No. N-11019/11/2019-HFA-V-UD (FTS-9061587)
Government of India
Ministry of Housing and Urban Affairs

Room No. 3, Technical Cell, Gate No. 7,
Nirman Bhawan, New Delhi
Dated 05th July, 2019

LETTER OF INVITATION

Dear Sir,

MINISTRY OF HOUSING AND URBAN AFFAIRS, GOVERNMENT OF INDIA (hereinafter called "MoHUA") has initiated the Global Housing Technology Challenge- India (GHTC-India) which aims to identify and mainstream a basket of innovative construction technologies from across the globe for affordable housing that are sustainable, green and disaster-resilient. In this regard, MoHUA is issuing Request for Proposal (RFP) for construction of Light House Projects (LHPs) at six sites, selected through a challenge process under GHTC-India.

2. MoHUA hereby invites the technical and financial proposals for construction of LHPs at six locations under GHTC-India using location specific exclusive alternate technologies which were shortlisted during the process of Construction Technology India-2019 Expo-cum-Conference.

3. The RFP includes the following sections:

Part-I: General Information
Part-II: Technical Bid
Part-III: Financial Bid
Section A – General Conditions of work and planning and designing
Section B – Conditions and specifications of works
Section C – Architectural Norms, Schedule of finishes and general specifications
Section D – Schedule of Stage Payments
Section E – Schedule of Quantities
Section F – Technical Specifications for shortlisted proven technologies
Section G – Drawing of EWS Housing for six Light House Project Sites

4. In case any holiday is declared by the Government on the day of opening, the tenders will be opened on the next working day at the same time. This RFP is being issued with no financial commitment and MoHUA reserves the right to change or vary any part thereof at any stage. MoHUA also reserves the right to withdraw the RFP, should it be so necessary at any stage.

5. It is not permissible to transfer this invitation to any other agency.

(B.K. Mandal)
Under Secretary to the Govt. of India
Tel: +91-11-23063285

CONFIDENTIAL



REQUEST FOR PROPOSAL (RFP) FOR ENGINEERING PROCUREMENT CONSTRUCTION MODE FOR THE DEVELOPMENT AND CONSTRUCTION OF EWS HOUSES UNDER LIGHT HOUSE PROJECTSIN SIX STATES AT SELECTED SITE UNDER GLOBAL HOUSING TECHNOLOGY CHALLENGE-INDIA (GHTC-INDIA)

Issued on:

Reference No. N-11019/11/2019-HFA-V-UD/ Computer No: 9061587

Organization: Ministry of Housing and Urban Affairs (MoHUA), Government of India.

Represented by:

Joint Secretary and Mission Director (HFA), MoHUA, Room No. 116 G, Nirman Bhawan, Maulana Azad Road, New Delhi -110011

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Certified that this bid-document contains 751 pages

Part-I: General Information

DISCLAIMER

The information contained in this Request for Proposal document (the "RFP") or subsequently provided to Participating Agency(s), whether verbally or in documentary or any other form by or on behalf of the Ministry of Housing and Urban Affairs (MoHUA), is provided to Participating Agency(s) on the terms and conditions set out in this RFP and such other terms and conditions subject to which such information is provided. The purpose of this RFP is to provide interested parties with information that may be useful to them in making their Technical and financial bids pursuant to this RFP.

This RFP includes statements, which reflect various assumptions and assessments arrived at by the MoHUA in relation to the Project. Such assumptions, assessments and statements do not purport to contain all the information that each Participating Agency may require in respect of technical specifications, drawings, layouts, soil investigation report, TSS etc.The assumptions, assessments, statements and information contained in the RFP Documents, may not be complete, accurate, adequate or correct in respect of above. Each participating agency should therefore, conduct its own investigations and analysis and should check the accuracy, adequacy, correctness, reliability and completeness of the assumptions, assessments, statements and information contained in this RFP and obtain independent advice from appropriate sources.

Information provided in this RFP to the participating agencies is on a wide range of matters, some of which may depend upon interpretation of law. The information given is not intended to be an exhaustive account of statutory requirements and should not be regarded as a complete or authoritative statement of law. Ministry of Housing and Urban Affairs accepts no responsibility for the accuracy or otherwise for any interpretation or opinion on law expressed herein.

The Ministry of Housing and Urban Affairs make no representation or warranty and shall have no liability to any person, including any Applicant or Participating Agency under any law, statute, rules or regulations or tort, principles of restitution or unjust enrichment or otherwise for any loss, damages, cost or expense which may arise from or be incurred or suffered on account of anything contained in this RFP or otherwise, including the accuracy, adequacy, correctness, completeness or reliability of the RFP and any assessment, assumption, statement or information contained therein or deemed to form part of this RFP or arising in any way for participation in this BID Stage.

The Ministry of Housing and Urban Affairs also accepts no liability of any nature whether resulting from negligence or otherwise howsoever caused arising from reliance of any Participating Agency upon the statements contained in this RFP. The Ministry of Housing and Urban Affairs may in its absolute discretion, but without being under any obligation to do so, update,

amend or supplement the information, assessment or assumptions contained in this RFP.

The issue of this RFP does not imply that the Ministry of Housing and Urban Affairs is bound to select a Participating Agency or to appoint the Participating Agency or Participating agency, as the case may be, for the Project and the Ministry of Housing and Urban Affairs reserves the right to reject all or any of the Participating Agency or bids without assigning any reason whatsoever.

The Participating Agency shall bear all its costs associated with or relating to the preparation and submission of its bid including but not limited to preparation, copying, postage, delivery fees, expenses associated with any demonstrations or presentations which may be required by the MoHUA or any other costs incurred in connection with or relating to its BID. All such costs and expenses will remain with the Participating Agency and the Ministry of Housing and Urban Affairs shall not be liable in any manner whatsoever for the same or for any other costs or other expenses incurred by a Participating Agency in preparation for submission of the BIDs, regardless of the conduct or outcome of the Bidding Process.

Information & instructions for Participating Agency for e-Bidding

REQUEST FOR PROPOSAL (RFP)

1.0 ABOUT GHTC-INDIA AND LIGHT HOUSE PROJECTS

Ministry of Housing and Urban Affairs (MoHUA), Government of India has been implementing Pradhan Mantri Awas Yojana-Urban (PMAY-U) Mission to provide all weather pucca houses to eligible beneficiaries by the year 2022. In order to address housing shortage in a time-bound manner, the conventional system of housing construction is not adequate to achieve the target by 2022. Hence, there was a need to look for new emerging, disaster-resilient, environment friendly, cost effective and speedy construction technologies which would form the basis of housing construction in India.

Hon'ble Prime Minister has envisaged a paradigm shift through technology transition using large scale construction under PMAY (U) as an opportunity to get the best available construction technologies across the globe. It has been envisioned to source technologies from all over the world and identify such technologies which would be suitable for adoption in India, given its unique geo-climatic conditions and user preferences based on diverse cultures. The shift in technology will address the large-scale housing construction in minimum time and minimum cost with efficient use of resources and environment friendly practices.

MoHUA launched "Global Housing Technology Challenge-India (GHTC-India)". The challenge has three components viz. i) Conduct of biennial Grand Expo-cum-Conference named Construction Technology India (CTI), ii) Identifying Proven Demonstrable Technologies from across the globe to construct Light House Projects (LHPs) iii) Promoting Potential Technologies (domestic) through the establishment of Affordable Sustainable Housing Accelerators- India (ASHA-India) for providing Incubation and Accelerator support.

GHTC-India was launched globally through a dedicated website, applications were invited online from proven technology providers. The Technical Evaluation Committee (TEC) interacted with applicants, who submitted online applications under Proven Demonstrable Technology category for GHTC-India. Technical presentations of their technologies were made before the TEC during CTI-2019 Expo-cum-Conference. MoHUA through TEC shortlisted basket of technologies suiting different geo-climatic conditions that could be considered for demonstration through actual ground implementation of six lighthouse projects located in six different States/UTs of PMAY(U) regions across the country.

The bids are being invited through this RFP to construct Light House projects (LHPs) for construction of about 1000 houses on approximately 2 Hectare of land within the framework of PMAY(U) on each selected site provided by States after using alternate technologies. The key challenge parameters for selection are the ability of the technology to deliver maximum

number of dwelling units in minimum time and in optimum cost. The project completion period in all respect is 12 months after handing over of site and approvals. All the statutory approvals will be provided by State/ULB/DA Officials on request of selected agency within 30 days from the date of award of contract to the selected agency to start timely construction work of LHPs as per contract as per committed LHP proposal to MoHUA.

An LHP shall mean a model housing project with about 1,000 houses built with alternate technology suitable to the geo-climatic and hazard conditions of the region .This will demonstrate and deliver ready to live-in houses with speed, economy and with better quality of construction in a sustainable manner. The minimum size of houses constructed under LHPs shall be up to 30 Square Meters carpet area in accordance with the prevailing guidelines of the Pradhan Mantri Awas Yojana)Urban.(However, carpet area of the house may increase as per the design proposed by selected agency/State/ULB/DA. Houses will be designed keeping in view the dimensional requirements laid down in National Building Code)NBC2016 with good aesthetics, proper ventilation, orientation, as required to suit the climatic conditions of the location and adequate storage space.

Each LHP will also include on-site infrastructure development such as internal roads, pathways, common green area, boundary wall, water supply, sewerage, drainage, rain water harvesting, solar lighting, external electrification, etc. as defined in scope of work .Cluster design may include innovative system of water supply and drainage, renewable energy sources with special focus on solar energy.

Convergence with other existing Centrally Sponsored Schemes and Missions such as Smart Cities Mission, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Swachh Bharat Mission (Urban), National Urban Livelihood Mission (NULM), Ujjwalla, Ujala, Make in India shall be ensured during the designing of LHPs at each site.

The structural details shall be designed to meet the durability and safety requirements of applicable loads including earthquakes and cyclone and flood in accordance with the applicable Indian/International standards.

The selected Agency completing the project in all respect within 12 months will be rewarded with USD 20,000 each (equivalent INR as per prevailing exchange rate) .A further incentive for early completion is being provided wherein agency who completes the project in less than 12 months will receive an incrementally higher bonus of USD 2,000 (equivalent INR as per prevailing exchange rate) for each less month than sanctioned 12 months.

Bids for each location will be invited on Engineering Procurement Construction (EPC) basis and selected agency shall submit Architectural drawings within 15 days and vetted structural design within 30 days after the approval of Architectural drawings, from the date of Letter of Award. The agency shall submit detailed drawings to the concerned authority of Ministry of Housing and Urban Affairs (MoHUA).

The project cost viz. the cost of Civil works along with internal infrastructure shall include planning and design charges, preparation of Detailed Project Report (hereinafter referred to as DPR) including Architectural and working drawings which are suitable for Construction, preparation of structural design, vetting of structural design from reputed institutions like IITs/ NITs, required testing from NABL accredited labs, contingency charges etc. Project cost shall also include infrastructure development cost including cost of construction of internal roads, pathways, common green area, boundary wall, water supply, water tank, site development, internal electrification, sewerage, drainage, firefighting system, lift shafts and machine room, lifts for multistory blocks, transformers along with HT/LT panel, Sewage Treatment Plant (STP) and DG set for emergency backup power for lift operation, etc.

These LHPs shall serve as open laboratories for different aspects of transfer of technologies to field application, such as planning, design, production of components, construction practices, testing etc. for both faculty and students of IITs /NITs /Engineering colleges /Planning and Architecture colleges, Builders, Professionals of Private and Public sectors and other stakeholders involved in such constructions .For this purpose, a sustained Information Education and Communication (IEC) activities shall be planned for Awareness and Promotion of new technologies through Multi-layered event publicity and web updates. IEC activities will be fully funded by Ministry of Housing and Urban Affairs (MoHUA).

During the process of housing construction, necessary data, information and other details will be collected for developing Schedule of Rates)SORs (by Central Public Works Department (CPWD) and Building Materials and Technology Promotion Council (BMTPC). Selected agency will provide necessary data & technical details for preparation of SOR & standard specifications for the Technology.

The updates during the construction of LHPs shall also be shared with National Knowledge Network (NKN) for making the young generation familiarized with the overall process of use of innovative technologies and technological advancements.

After completion of the LHPs in all respect, it will be handed over to the concerned State Govt./ ULB/ DA by the selected agency after issuance of NOC from MoHUA. Further, normal routine maintenance of the LHPs will be responsibility of concerned State/ ULB/ DA and expenditure will be met by State Govt./ ULB/ DA. However, any remedial measures pertaining to structural issues/ major distress occurring in the project/ houses will be taken up by the selected agency at their own cost for a period of five years from the date of completion of project. After allotment of LHPs to the beneficiaries, the same will be maintained as per the provisions under PMAY (U) Guidelines.

To ensure sustainability after the houses are constructed, the selected agency shall ensure that an effective maintenance Manual is in place and necessary training and handholding is provided to State/ ULB/ DA officials,

regarding relevant maintenance measures of the projects within five years of defect liability period.

2.0 MoHUA hereby invites technical and financial bids for construction of LHPs at following six locations under GHTC-India using location specific exclusive alternate technologies(Annexure-A)which were shortlisted during the process of CTI-2019:

i. Indore, Madhya Pradesh
ii. Rajkot, Gujarat
iii. Chennai, Tamil Nadu
iv. Ranchi, Jharkhand
v. Agartala, Tripura
vi. Lucknow, Uttar Pradesh

The location plan/lay-out plans and other relevant drawings of each project are mentioned in Section G

3.0 Accordingly, MoHUA invites online Technical and Financial bids from agencies who are willing to adopt shortlisted technologies provided by the technology providers as given in Annexure-A for construction of Light House Projects containing Affordable Housing of about 1000 EWS housing units and associated services at above locations.

All residential buildings under LHPs shall be built only with the alternate technologies listed in Annexure-A. In case one proposed unique technology is not suitable for specific site as per structural and local geo-climatic requirement, the participating agency may use hybrid construction system other than conventional system subject to proof of its structural safety, fire safety, thermal performance and fulfillment of other functional requirements of the buildings. The participating agencies required to submit a detailed note on specification and code of practice and how the particular technology can be effectively used in proposed LHP.

3.1 The Participating agency eligible for participating in the bidding process shall be from any one of the following two categories otherwise bids will be considered as non-responsive:

i. **Category 1:** Single Business Entity shortlisted through the GHTC-India process.
ii. **Category 2:** A Consortium/Joint venture of Business Entities (hereinafter referred to as "Consortium") with one shortlisted agency from GHTC-India (category-1)

The term Participating agency would hereinafter apply to both the above-mentioned categories.

3.1.1 For the purpose of this RFP, the participating agency shall mean a business Entity incorporated under the Indian Companies Act 1956/2013 or incorporated under equivalent law abroad/Agency should be Participating Agency and should submit registration Certificates & GST Registration/incorporation under the governing legislation as applicable. The Agency shall be required to submit a

true copy of its Incorporation Certificate along with the Proposal.

3.2 For ease of evaluation, award and implementation of LHPs, the works at above six locations have been divided into six different packages based on location as below:

Site and Construction Area Details of 6 LHPs

S. No	Particulars	Unit	Madhya Pradesh	Gujarat	Tamil Nadu	Jharkhand	Tripura	Uttar Pradesh
1	**Proposed Residential Area**(Drawings attached)	S : Stilt G: Ground	S+8	S+13	G+5	G+8	G+6	G+13
2	Land (Plot) Area	In Sqm.	41920.00	39,599.00	33595.98	31,160.82	24,000.0	20000.0
3	Net Plot Area	In Sqm.	34,276.00	39,599.00	33595.98	31,160.82	24,000.0	20000.00
4	Permissible FSI	FSI	1.50	2.70	1.30	3.5	1.20	2.50
5	No. of DUs proposed	No.	1024	1144	1152	1008	1000	1040
6	Carpet Area per Dwelling Unit	Sqm.	34.98	39.77	26.58	29.85	30.0	30.00
7	Total Residential Built-up/ Covered Area including Circulation	Sqm.	56944.80	74,207.87	43476.48	38,004.54	43,590.60	47,788.0
8	Green Area	Sqm.	3445.00	2,500.00	5,043.09	6454.28	3,600.0	3000.0
Proposed Social Infrastructure/ Facility to be provided as per State requirement and NBC 2016 Norms by the selected agency								
9	Community Centre/ Hall Built-up Area	Sqm.	169.52	1270.80	As per layout	3168	1680.00	As per layout
10	Commercial Area/ Shop Built-up Area	Sqm.	-	986.75		-		As per layout
11	Aanganwadi/ Nursery/ Primary School Built-up Area	Sqm.	-			-		As per layout
12	Milk Booth Built-up Area	Sqm.	-			-		As per layout
13	Health Center	Sqm.	-			-		As per layout

Note: Number of houses, floors, built-up/ carpet area may vary as per the plan & location subject to approval from Competent Authority.

1. Suggestive Scope of Work for Construction of LHP 1 at Indore, Madhya Pradesh

1.	Proposed Residential Area (Drawings attached)	Stilt + 8
2.	Land (Plot) Area	41,920.00 sqm.
3.	Net Plot Area after deducting road widening area	34,276.00 sqm.
4.	Permissible FSI	1.50
5.	No. of DUs proposed	1024
6.	Carpet Area per Dwelling Unit	34.98 Sqm.
7.	Proposed Total Residential Built-up Area (including Circulation)	56,944.80 Sqm.
8.	Proposed Green Area	3,445.00 Sqm.

9. Selected Agency will be required to provide Social Infrastructure with built-up area as mentioned
    i. Community Centre/ Hall Built-up Area 169.52 Sqm
    ii. Commercial Area/ Shop Built-up Area, Aanganwadi/ Nursery/ Primary School Built-up Area, Milk Booth Built-up Area, Health Center:
    To be provided as per drawings mentioned in Section G and requirements of State
10. Selected Agency will be required to provide all necessary infrastructure facilities at site along with drawings but not limited to following mentioned as:
    i. Internal Water Supply
    ii. Laying of Sewerage Pipe Line
    iii. RCC storm water drain
    iv. Provisions for Fire Fighting
    v. Internal Electrification
    vi. Internal Road & Pathway (CC Road and Bituminous Road)
    vii. Providing Lifts in building blocks
    viii. Landscaping of site
    ix. Street light with fluorescent lamps
    x. Solar Street Light System
    xi. Sewerage Treatment Plant/ Septic Tank
    xii. External Electrification
    xiii. Water Supply System including underground water reservoir
    xiv. Compound wall with Boundary Gates
    xv. Horticulture facilities
    xvi. Rain Water Harvesting
    xvii. Solid Waste Management

2. Suggestive Scope of Work for Construction of LHP 2 at Rajkot, Gujarat

1. Proposed Residential Area (Drawings attached) — Stilt floor + 13
2. Land (Plot) Area — 39,599.00 sqm.
3. Permissible FSI — 2.70
4. No. of DUs proposed — 1144
5. Carpet Area per Dwelling Unit — 39.77Sqm.
6. Proposed Total Residential Built-up Area (including Circulation) — 74,207.87Sqm.
7. Proposed Green Area — 2,500.00Sqm.
8. Selected Agency will be required to provide Social Infrastructure with built-up area as mentioned
    i. Community Centre/ Hall Built-up Area — 1270.80 Sqm.
    ii. Commercial Area/ Shop Built-up Area, Aanganwadi/ Nursery/ Primary School Built-up Area, Milk Booth Built-up Area, Health Center: 986.75 Sqm.
9. Selected Agency will be required to provide all necessary infrastructure facilities at site along with drawings but not limited to following mentioned as:
    i. Internal Water Supply
    ii. Laying of Sewerage Pipe Line
    iii. RCC storm water drain
    iv. Provisions for Fire Fighting
    v. Internal Electrification
    vi. Internal Road & Pathway (CC Road and Bituminous Road)
    vii. Providing Lifts in building blocks
    viii. Landscaping of site
    ix. Street light with fluorescent lamps
    x. Solar Street Light System
    xi. Sewerage Treatment Plant/ Septic Tank
    xii. External Electrification
    xiii. Water Supply System including underground water reservoir
    xiv. Compound wall with Boundary Gates
    xv. Horticulture facilities
    xvi. Rain Water Harvesting
    xvii. Solid Waste Management

3. Suggestive Scope of Work for Construction of LHP 3 at Chennai, Tamil Nadu

1.	Proposed Residential Area (Drawings attached)	Ground + 5
2.	Land (Plot) Area	33595.98 sqm.
3.	Permissible FSI	1.30
4.	No. of DUs proposed	1152
5.	Carpet Area per Dwelling Unit	26.58 Sqm.
6.	Proposed Total Residential Built-up Area (including Circulation)	43,476.48Sqm.
7.	Proposed Green Area	5,043.09 Sqm.

8. Selected Agency will be required to provide Social Infrastructure with built-up area as mentioned

   Community Centre/ Hall Built-up Area, Commercial Area/ Shop Built-up Area, Aanganwadi/ Nursery/ Primary School Built-up Area, Milk Booth Built-up Area, Health Center: To be provided as per drawings mentioned in Section G and requirements of State

9. Selected Agency will be required to provide all necessary infrastructure facilities at site along with drawings but not limited to following mentioned as:
   i. Internal Water Supply
   ii. Laying of Sewerage Pipe Line
   iii. RCC storm water drain
   iv. Provisions for Fire Fighting
   v. Internal Electrification
   vi. Internal Road & Pathway (CC Road and Bituminous Road)
   vii. Providing Lifts in building blocks
   viii. Landscaping of site
   ix. Street light with fluorescent lamps
   x. Solar Street Light System
   xi. Sewerage Treatment Plant/ Septic Tank
   xii. External Electrification
   xiii. Water Supply System including underground water reservoir
   xiv. Compound wall with Boundary Gates
   xv. Horticulture facilities
   xvi. Rain Water Harvesting
   xvii. Solid Waste Management

4. Suggestive Scope of Work for Construction of LHP 4 at Ranchi, Jharkhand

1. Proposed Residential Area (Drawings attached) — Ground floor + 8
2. Land (Plot) Area — 31,160.82 sqm.
3. Permissible FSI — 3.50
4. No. of DUs proposed — 1008
5. Carpet Area per Dwelling Unit — 29.85 Sqm.
6. Proposed Total Residential Built-up Area (including Circulation) — 38,004.54 Sqm.
7. Proposed Green Area — 6,454.28 Sqm.
8. Selected Agency will be required to provide Social Infrastructure with built-up area as mentioned
   i. Community Centre/ Hall Built-up Area — 3,168.00 Sqm.
   ii. Commercial Area/ Shop Built-up Area, Aanganwadi/ Nursery/ Primary School Built-up Area, Milk Booth Built-up Area, Health Center
   To be provided as per drawings mentioned in Section G and requirements of State
9. Selected Agency will be required to provide all necessary infrastructure facilities at site along with drawings but not limited to following mentioned as:
   i. Internal Water Supply
   ii. Laying of Sewerage Pipe Line
   iii. RCC storm water drain
   iv. Provisions for Fire Fighting
   v. Internal Electrification
   vi. Internal Road & Pathway (CC Road and Bituminous Road)
   vii. Providing Lifts in building blocks
   viii. Landscaping of site
   ix. Street light with fluorescent lamps
   x. Solar Street Light System
   xi. Sewerage Treatment Plant/ Septic Tank
   xii. External Electrification
   xiii. Water Supply System including underground water reservoir
   xiv. Barbed wire fencing with compound gates
   xv. Horticulture facilities
   xvi. Rain Water Harvesting
   xvii. Solid Waste Management

5. Suggestive Scope of Work for Construction of LHP 5 at Agartala, Tripura

1.	Proposed Residential Area (Drawings attached)	Ground + 6
2.	Land (Plot) Area	24000.00 sqm.
3.	Permissible FSI	1.2
4.	No. of DUs proposed	1000
5.	Carpet Area per Dwelling Unit	30.0 Sqm.
6.	Proposed Total Residential Built-up Area (including Circulation)	43,590.60Sqm.
7.	Proposed Green Area	3,600.00Sqm.

8. Selected Agency will be required to provide Social Infrastructure with built-up area as mentioned

   Community Centre/ Hall Built-up Area, Commercial Area/ Shop Built-up Area, Aanganwadi/ Nursery/ Primary School Built-up Area, Milk Booth Built-up Area, Health Center: To be provided as per drawings mentioned in Section G and requirements of State

9. Selected Agency will be required to provide all necessary infrastructure facilities at site along with drawings but not limited to following mentioned as:
   - i. Internal Water Supply
   - ii. Laying of Sewerage Pipe Line
   - iii. RCC storm water drain
   - iv. Provisions for Fire Fighting
   - v. Internal Electrification
   - vi. Internal Road & Pathway (CC Road and Bituminous Road)
   - vii. Providing Lifts in building blocks
   - viii. Landscaping of site
   - ix. Street light with fluorescent lamps
   - x. Solar Street Light System
   - xi. Sewerage Treatment Plant/ Septic Tank
   - xii. External Electrification
   - xiii. Water Supply System including underground water reservoir
   - xiv. Compound wall with Boundary Gates
   - xv. Horticulture facilities
   - xvi. Rain Water Harvesting
   - xvii. Solid Waste Management

6. Suggestive Scope of Work for Construction of LHP 6 at Lucknow, Uttar Pradesh

1.	Proposed Residential Area (Drawings attached)	Stilt + 13
2.	Land (Plot) Area	20,000.00 sqm.
3.	Permissible FSI	2.50
4.	No. of DUs proposed	1040
5.	Carpet Area per Dwelling Unit	34.50 Sqm.
6.	Proposed Total Residential Built-up Area (including Circulation)	47,788.0 Sqm.
7.	Proposed Green Area	3000.0 Sqm.

8. Selected Agency will be required to provide Social Infrastructure with built-up area as mentioned

   Community Centre/ Hall Built-up Area, Commercial Area/ Shop Built-up Area, Aanganwadi/ Nursery/ Primary School Built-up Area, Milk Booth Built-up Area, Health Center: To be provided as per drawings mentioned in Section G and requirements of State.

9. Selected Agency will be required to provide all necessary infrastructure facilities at site along with drawings but not limited to following mentioned as:
   i. Internal Water Supply
   ii. Laying of Sewerage Pipe Line
   iii. RCC storm water drain
   iv. Provisions for Fire Fighting
   v. Internal Electrification
   vi. Internal Road & Pathway (CC Road and Bituminous Road)
   vii. Providing Lifts in building blocks
   viii. Landscaping of site
   ix. Street light with fluorescent lamps
   x. Solar Street Light System
   xi. Sewerage Treatment Plant/ Septic Tank
   xii. External Electrification
   xiii. Water Supply System including underground water reservoir
   xiv. Compound wall with Boundary Gates
   xv. Horticulture facilities
   xvi. Rain Water Harvesting
   xvii. Solid Waste Management

Bid Document No.	**1. N-11019/11/2019-HFA-V-UD/ Computer No: 9061587/ Package I for Madhya Pradesh** **2. N-11019/11/2019-HFA-V-UD/ Computer No: 9061587/ Package II for Gujarat** **3. N-11019/11/2019-HFA-V-UD/ Computer No: 9061587/ Package III for Tamil Nadu** **4. N-11019/11/2019-HFA-V-UD/ Computer No: 9061587/ Package IV for Jharkhand** **5. N-11019/11/2019-HFA-V-UD/ Computer No: 9061587/ Package V for Tripura** **6. N-11019/11/2019-HFA-V-UD/ Computer No: 9061587/ Package VI for Uttar Pradesh**
Name of the Work (for each package)	Construction of about 1000 dwelling units with associated facilities and services by using any of the location specific shortlisted alternate technologies at six locations and maintaining them during the defect liability period.
Brief Scope of Work (form each package)	Design and Construction of about 1000 number of EWS dwelling units including associated facilities and services by using any of the location specific shortlisted alternate Technologies as per the approved architectural and structural drawings including building and site infrastructure Arranging required material, machinery and manpower so as to complete the job within the quoted cost and specified time period. Maintenance of structure and lifts during defect liability period.
Number of Houses and number of floors to be constructed at sites	Proposed number of houses and number of floors for all sites are indicative, after the finalization of layout plan by selected agency in consultation with State Govt./ MoHUA. The number of houses and floors may increase or decrease based on final approved layout.
Project Duration	15 Months (3 months for planning and taking statutory approvals from local authorities + 12 months for construction of each package from date of handing over of site and all statutory approvals)
Estimated Project Cost	Rs 125.0 Crore (Rupees One hundred and twenty five Crore) only
Earnest Money Deposit	Rs 2.5 crore (Rupees two crore fifty lakh) only as per Note provided.**EMD in form of Bank Guarantee to be issued in name of PAO (Sectt.), MoHUA payable at New Delhi** **Note:** If one particular agency applies with one technology for more than one location, one EMD shall be submitted. However, if one agency is applying for one or more technologies with different locations, separate EMD shall be submitted.

Last date & time of submission of Online Bid (for all packages)	Up to 20.08.2019
Period during which hard copy in original of EMD and Technical Bid to be submitted (for all packages)	Up to 20.08.2019 on or before the date of opening of Technical Bid
Date & Time of Opening of Technical Bid (for all packages)	21.08.2019
Pre-Bid Meeting & Venue (for all Sites)	29.07.2019 at Room No. 101 A, CPWD Conference Hall, Nirman Bhawan, New Delhi
Date & Time of Opening of Financial Bid (for all packages)	To be Intimated Later
Validity of offer	120 days from the date of opening of technical bid.

a. The bid documents can be downloaded from www.eprocure.gov.in , www.ghtc-india.gov.in and www.mohua.gov.in

b. Bids (technical bid) will be opened in descending order as per the land area of the project as given below.

Sl. No	Project Location	Land Area (sqm.)
1	Madhya Pradesh	41920.00
2	Gujarat	39599.00
3	Tamil Nadu	33595.98
4	Jharkhand	31160.82
5	Tripura	24000.00
6	Uttar Pradesh	20000.00

c. The Participating Agency are free to participate in the bidding process for more than one location. However, in order to propagate the use of different alternate technologies across the regions, lowest Participating Agency with one of the shortlisted technologies would be allotted work in one region only using that specific technology.

d. Once a particular technology (as distinct from technology provider) has been selected for one location, all the bids using the same technology for other locations shall not be opened. This will ensure that different locations will have separate technologies.

e. All payments made by MoHUA will be in Indian currency. Any agency, including a foreign firm shall have no claim for payment in any other currency or to them.

f. "Corrigendum/ Addendum/ Minutes of Pre-bid Meeting, if any, would appear only on the website and shall not be published in any News Paper".

4.0 Minimum Eligibility Criteria for each package:

The interested Participating Agency should meet the following minimum qualifying criteria:

A. Work Experience:

i. Experience of having successfully completed similar works during the last 7 years ending previous day of last date of submission of bids:

a. Three similar works each costing not less than 40% of the estimated cost put to bid

OR

b. Two similar works each costing not less than 60% of the estimated cost put to bid

OR

c. One similar work costing not less than 80% of the estimated cost put to bid.

ii. "Similar works for Building Works" using proposed alternate technology/ hybrid proposed technology/ any other technology. The definition of similar work shall mean "Residential/Non-Residential buildings as per CPWD Works Manual 2019 and SOP (Mumty and Machine Room will not be counted as storey/height for this purpose, if Ground Floor is stilt, it will be counted as storey).

iii. The past experience in similar nature of work should be supported by certificates issued by the client's organization. In case the work experience is of Private sector the completion certificate shall be supported with copies of Letter of Award and copies of corresponding TDS certificates. In case of foreign firms, necessary evidences with respect to taxes may be attached appropriately.

iv. The value of executed works shall be brought to the current level by enhancing the actual value of work done at a simple rate of 7% per annum, calculated from the date of completion to previous day of last day of submission of bids.

B. Financial Strength:

i) The Average annual financial turnover of last consecutive fiscal years for last immediate 5 years shall be at least 50% of the estimated cost put to bid for each project location. The requisite Turnover shall be duly certified by

a Chartered Accountant with his Seal/ signatures and registration number.

ii) Net Worth of the participating agency as on 31st March of previous Financial Year should be positive.

iii) **Self certified copy of** Bank Solvency Certificate issued from Nationalized or any Schedule Bank should be at least 40% of Estimated Cost of the Project put to bid. The certificate should have been issued within 6 months from original last date of the submission of the bid.

iv) The Participating Agency should not have incurred any loss in more than two years during available last five consecutive balance sheets. The Participating Agency are required to upload and submit page of summarized Balance Sheet (Audited) and also page of summarized Profit & Loss Account (Audited) for last five years.

C. In case of Joint-venture/consortia of firms/companies:

1. A Consortium of a maximum of **three (3) members** of above such entities comprising one Lead Member with two other members shall be allowed and shall hereinafter be referred as "Consortium".

2. The Participating Agency should submit a Power of Attorney authorizing the signatory of the Application to commit the Participating Agency.

3. Bids submitted by a Consortium should comply with the following additional requirements:

    a. The number of members in the Consortium would be limited to three (3);
    b. The Application should contain the information required from each member;
    c. The Application should include a description of the roles and responsibilities of all the members;
    d. Members of the Consortium shall nominate one member as the Lead Member and that member must be an entity as defined above;
    e. The Participating agency who has participated in this bid in its individual capacity or as part of a Consortium cannot participate as a separate agency of any other Consortium participating in this bid;
    f. The members of the Consortium shall execute a Power of Attorney for Lead Member of Consortium.
    g. The members of the Consortium shall enter into a Memorandum of Understanding (MoU), for the purpose of submission of the Application. The MoU should, inter alia,

        i. Clearly outline the proposed roles and responsibilities of each member of the Consortium; and
        ii. Include a statement to the effect that all members of the

Consortium shall be liable jointly and severally for the assignments arising out contract agreement therefore;

iii. A copy of the MoU signed by all members should be submitted along with the technical bids. The MoU entered into between the members of the Consortium should contain the above requirements, failing which the Application shall be considered non-responsive.

4. A Participating agency or Consortium which has earlier been barred by MoHUA or blacklisted by any State /UT Government or Central Government / department / agency in India from participating in Bidding Process shall not be eligible to submit bids, either individually or as member of a Consortium, if such bar subsists as on the submission Due Date. The Participating agency or Consortium shall be required to furnish an affidavit that there is no such bar imposed and existing as on date.

5. A Participating Agency declared ineligible by multilateral agencies or Government of India or State Governments and debarred from providing the man power in India shall be ineligible to submit bids. In case the Participating agency or any member of Consortium is declared ineligible by multilateral agencies or Government of India or State Governments during the evaluation period then such bids shall be excluded from the evaluation process with MoHUA.

6. A Participating agency or member of Consortium should have, during the last three years, neither failed to perform on any agreement, as evidenced by imposition of a penalty or a judicial pronouncement or arbitration award against the Participating Agency or member of Consortium, nor been expelled from any project or agreement nor have had any agreement terminated for breach by such Participating Agency or member of Consortium.

7. Each participating agency shall submit only one proposal for each site. Any participating agency, which submits or participates in more than one bid for the same will be disqualified. However participating agency can submit bids for different sites.

8. The Application and all related correspondence and documents should be furnished by the participating Agency with the Application may be in any other language provided that these are accompanied by appropriate translations of the pertinent passages in the English language by approved/authorized/ licensed translator. Supporting material, which are not translated into English, may not be considered. For the purpose of interpretation and evaluation of the Application, the English language translation shall prevail.

9. Participating agency/consortium should be profit making organization. The audited balance sheet for the last three years may be attached with the technical bids, otherwise bids will be rejected.

10. Under GHTC-India, MoHUA have enlisted Indian Support

Partners who have relevant experience of construction and have shown interest in partnering for the purpose. The participating agency (ies) may explore possibilities of further associations, logistic supports, etc with these partners on their own. However, this enlistment is not a binding on any participating agency. The participating agencies are free to have JV/ consortium with any business entity from this enlistment or any other as the case may be. List of Indian support partners may be accessed at ghtc-mhua@gov.in

5.0 Foreign Work Experience Certificate:

i. In case the work experience is for the work executed outside India, the Participating Agency have to submit the completion/experience certificate issued by the owner duly signed &stamped and affidavit to the correctness of the completion/experience certificates. The Participating Agency shall also get the completion/experience certificates attested by the Indian Embassy/Consulate/High Commission in the respective country.

ii. In the event of submission of completion /experience certificate by the Participating Agency in a language other than English, the English translation of the same shall be duly authenticated by Chamber of Commerce of the respective country and attested by the Indian Embassy/Consulate / High Commission in the respective country.

iii. For the purpose of evaluation of Participating Agency, the conversion rate of such a currency into INR shall be the daily representative exchange rate published by the IMF as on 7 (Seven) days prior to the Last Date of Submission of bid including extension(s) given if any.

6.0 The Participating Agency are required to quote strictly as per terms and conditions, specifications, standards of alternate technologies provided in the bid documents and not to stipulate any deviations.

7.0 The Participating Agency are advised to submit complete details with their bids as Technical Bid Evaluation will be done on the basis of documents uploaded on website by the Participating Agency with the bids. The information should be submitted in the prescribed proforma. Bids with Incomplete /Ambiguous information will be rejected.

8.0 The Bank Guarantee for EMD submitted by the Participating Agency shall be strictly in the format prescribed in Form-G. In case, EMD is not found verbatim in the prescribed format, the bid will be liable for rejection.

9.0 The Participating Agency are advised in their own interest to submit their bid documents well in advance from last date/time of submission of bids so as to avoid problems which the Participating Agency may face in submission at last moment /during rush hours.

10.0 When it is desired by MoHUA to submit revised financial bid within the validity period then it shall be mandatory to submit revised

financial bid. If not submitted then the bid submitted earlier shall become invalid and EMD will be forfeited.

11.0 If the Participating Agency is found ineligible after opening of bids, his bid shall become invalid and cost of processing fee shall not be refunded.

12.0 Notwithstanding anything stated above, MoHUA reserves the right to assess the capabilities and capacity of the Participating Agency to perform the contract, in the overall interest of MoHUA. In case, Participating Agencies capabilities and capacities are not found satisfactory, MoHUA reserves the right to reject the bid.

13.0 **Certificate of Financial Turnover**: At the time of submission of bid, the Participating Agency shall upload Affidavit/Certificate from Chartered Accountant mentioning Financial Turnover of last 5 years or for the period as specified in the bid document. There is no need to upload entire voluminous balance sheet. However, one page of summarised balance sheet (Audited) and one page of summarized Profit &Loss Account (Audited) for last 05years shall be uploaded and submitted in hard copy also.

14.0 The Participating Agency (s) if required, may submit queries, if any, through E-mail and in writing to the bid inviting authority to seek clarifications upto date of pre-bid meeting from the date of uploading of bid document on website. MoHUA will reply to only those queries which are essentially required for submission of bids. MoHUA will not reply to the queries which are not considered fit like replies of which can be implied/found in the NIT/ Bid Documents or which are not relevant or in contravention to NIT/Bid Documents, queries received after 7days from the date of uploading of Bid on website. Technical Bids are to be opened on the scheduled dates. Requests for Extension of opening of Technical Bids will not be entertained.

15.0 Pre-bid meeting shall be held with the eligible and intending Participating Agency at stated time and venue as mentioned earlier in RFP. As a result of pre-bid meeting, certain modifications may be issued to all eligible Participating Agency by MoHUA corrigendum, if felt necessary. All modifications/addendums/corrigendum issued regarding this bidding process, shall be uploaded on website only and shall not be published in any Newspaper.

16.0 Attending the pre-bid meeting is optional. Participating Agency should contact MoHUA to arrange for their visit or to obtain additional information on the pre-bid meeting. Firms should ensure that these representatives are advised of the visit in adequate time to allow them to make appropriate arrangements. The Pre-Bid meeting shall be attended by the intending Participating Agency only and not by vendors/manufacturers. Further, the intending Participating Agency should depute their authorized person with authorization letter in original to attend the pre-bid meeting.

17.0 **Integrity Pact**

17.1 Integrity Pact duly signed by the Participating Agency shall be submitted as per ANNEXURE-III. Any bid without signed integrity Pact shall be liable for rejection.

18.0 **List of Documents to be uploaded within the period of bid submission:**

a) Bank Guarantee of any Nationalized or all Commercial Scheduled Bank against EMD as per FORM-G.
b) Memorandum as Annexure-IV.
c) Unconditional Letter of Acceptance of Bid Conditions (in original) mentioned in Part 3Financial Bid (On Letter Head of the Applicant/ Participating Agency).
d) Integrity pact duly signed by the participating agency (Annexure-III).The Participating Agency are required to download the Integrity Pact as uploaded in the bid documents, and sign on the same, put rubber stamp/seal and upload the signed copy on e-biding websites.
e) Financial information of Participating Agency - FORM-A.
f) Banker's Solvency Certificate- FORM-B.
g) Details of Similar Works and work Experience Certificates- FORM-C.
h) Structure and Organization Details of Firm – FORM E
i) EMD Receipt Format – FORM F
j) Documents regarding Net Worth of the Company/Firm.
k) Form-Hof Contract Conditions -Affidavit duly notarized by Notary Public on Non Judicial Stamp Paper of Rs. 100 for correctness of Documents /Information.
l) Power of Attorney of the person authorized for signing/submitting the bid.
m) Valid GST registration/EPF registration/PAN NO.
n) All pages of the entire Corrigendum (if any) duly signed by the authorized person.
o) Pre-bid clarifications, if any.
p) Registration Details of the participating agency as per GST Act in the State at the location of the Project– Form-I
q) Details of Administrative and Technical staff to be associated in the project
r) Geographical presence of the Participating agency

NOTE: All the uploaded documents should be in readable, printable and legible form failing which the Bids shall not be considered for evaluation. The relevant Annexure may be tabled with proper indexing.

19.0 (a)No Clarification will be sought in case of non-submission of EMD of requisite amount or Unconditional letter of acceptance or Affidavit for correctness of document/information. In such cases the bid shall be rejected out rightly without seeking any further clarification/document.

(b) All the uploaded and submitted documents shall be considered as duly signed by authorized representative of Participating Agency.

20 The bid submitted shall become invalid if:

(i) The participating agency is found ineligible.
(ii) The participating agency does not deposit EMD with office of MoHUA
(iii) The participating agency does not upload all the documents as stipulated in the bid document.
(iv) If any discrepancy is noticed between the documents as uploaded at the time of submission of bid.
(v) Participating agency bid with deviation or conditional bid.

21.0 UNFAIR ADVANTAGE

21.1 **Penalty for use of Undue influence**: -The Firms undertakes that it has not given, offered or promised to give, directly or indirectly, any gift, consideration, reward, commission, fees, brokerage or inducement to any person in service of the MoHUA or otherwise in procuring the Contracts or forbearing to do or for having done or forborne to do any act in relation to the obtaining or execution of the present Contract or any other Contract with the Government of India for showing or forbearing to show favour or disfavor to any person in relation to the present Contract or any other Contract with the Government of India. Any breach of the aforesaid undertaking by the Firms or any one employed by him or acting on his behalf (whether with or without the knowledge of the Firms) or the commission of any offers by the Firms or anyone employed by him or acting on his behalf, as defined in Chapter IX of the Indian Penal Code, 1860 or the Prevention of Corruption Act,1986 or any other Act enacted for the prevention of corruption shall entitle the MoHUA to cancel the contract and all or any other contracts with the Firms and recover from the Firms the amount of any loss arising from such cancellation. A decision of the MoHUA or his nominee to the effect that a breach of the undertaking had been committed shall be final and binding on the Firms. Giving or offering of any gift, bribe or inducement or any attempt at any such act on behalf of the Firms towards any officer/employee of the MoHUA or to any other person in a position to influence any officer/employee of the MoHUA for showing any favour in relation to this or any other contract, shall render the Firms to such liability/ penalty as the MoHUA may deem proper, including but not limited to termination of the contract, imposition of penal damages, forfeiture of the Bank Guarantee and refund of the amounts paid by the MoHUA.

21.2 If a Firm could derive a competitive advantage from having provided consulting Assignment/Job related to the Assignment/Job in question and which is not defined as conflict of interest, the MoHUA shall make available to all Firms together with this RFP all information that would in that respect give such Firms any competitive advantage over competing Firms.

21.3 Canvassing in connection with the bid are strictly prohibited, and such canvassed bids submitted by the participating agency will be liable to be rejected and his earnest money shall be absolutely forfeited.

21.4 MoHUA reserves the right to reject any or all bids or cancel/withdraw the invitation for bid without assigning any reasons whatsoever

thereof. No claim of the participating agency whatsoever shall be entertained by MoHUA on this account.

21.5 In case of any query, please contact on Ph. No. 011-23063266 and E-mail:jshfa-mhupa@gov.in, dirhfa5-mhupa@gov.in,clsshfa5@yahoo.com and ghtc-mhua@gov.in

(B.K. Mandal)
Under secretary to the Govt. of India
MoHUA
Tel: +91-11-23063285

ANNEXURE-I

Instructions for Online Bid Submission

1. All interested Participating Agency are requested to register themselves with the portal http://eprocure.gov.in and enroll their digital certificate with the user id for participation in the bid.

2. Participating Agency are requested to read following conditions in conjunction with various conditions, wherever applicable appearing with this bid invitation for e-Biding. The conditions mentioned here in under shall supersede and shall prevail over the conditions enumerated elsewhere in the bid document.

3. How to submit On-line Bids/Offers electronically against e-Biding?

Participating Agency are advised to read the following instructions for participating in the electronic bids directly through internet:

i) Late and delayed Bids/Offers after due date/time shall not be permitted in e-Biding system. No bid can be submitted after the last date and time of submission is over. The system time (IST) that will be displayed on e-biding web page shall be the time and no other time shall be taken into cognizance.
ii) Participating Agency are advised in their own interest to ensure that bids are uploaded in e-biding system well before the closing date and time of bid.
iii) No bid can be modified after the dead line for submission of bids.
iv) No manual bids/offers along with electronic bids / offers shall be permitted.

4. What is a Digital Signature?

This is a unique digital code which can be transmitted electronically and primarily identifies a unique sender. The objective of digital signature is to guarantee that the individual sending the message is who he or she really claims to be just like the written signature. The Controller of Certifying Authorities of India (CCA) has authorized certain trusted Certifying Authorities (CA) who in turn allots on a regular basis Digital Signature Certificates (DSC).

5. Documents which are signed digitally are legally valid documents as per Indian IT Act (2000).

6. Why is a Digital Signature required?

In order to bid for MOHUA e-bids all the vendors are required to obtain a legally valid Digital Certificate as per Indian IT Act from the licensed Certifying Authorities (CA) operating under the Root Certifying Authority of India (RCAI), Controller of Certifying Authorities (CCA) of India. The Digital Certificates is issued by CA in the name of a person authorized for filing Bids/Offers on behalf of his Company. A Vendor/ Participating

agency can submit their Bids/Offers on-line only after digitally signing the bid/documents with the above allotted Digital Signatures.

7. Participating Agency have to procure Digital Signature Certificate (Class 3 or 2 with signing key uses) from any of the certifying Authorities in India.

8. Submission of Documents

i) Participating Agency must submit on line offers by the date and time mentioned in the RFP at the website address stated therein.

ii) Each E-Bid will provide access to Commercial as well as Price part of bid. Along with the Commercial part, Participating Agency can attach the required documents along with scan copy of Bank Guarantee for EMD with the bid in line with the Bid.

iii) The successful bid submission can be ascertained once acknowledgement is given by the system through bid submission number after completing all the process and steps.

iv) The bid have to be submitted online as well as physical submission. However, documents which necessarily have to be submitted in originals like Technical Proposal for each location, EMD and any other documents mentioned in the bid documents have to be submitted offline. Prices should not be submitted in a sealed envelope. MoHUA shall not be responsible in any way for failure on the part of the participating agency to follow the instructions.

v) Financial Bid shall contain only price as per Schedule of Rates (in form of an excel sheet) without any condition. The lump sum rate along with tax and other components shall be filled up in figures and the total amount shall be automatically calculated and rounded off to the nearest rupee. It is to be noted that the Financial Bid shall contain only PRICES and no conditions whatsoever.

vi) The online bid shall be uploaded through digital signatures by someone legally authorized to enter into commitment on behalf of the Participating agency. Participating agency shall upload among other documents, power of Attorney in favour of the person who is authorized to enter into commitments on behalf of the Participating agency.

vii) It is advised that the participating agency upload small sized documents (preferably upto 5 MB) at a time to facilitate in easy uploading into e-biding site. MoHUA does not take any responsibility in case of failure of the participating agency to upload the documents within specified time of bid submission.

(viii) The participating agency(ies) shall submit the Technical Bids in the format as mentioned in RFP **online** and also submit **its hard copy** in sealed envelope and mark the envelope as “RFP for Engineering Procurement Construction bid for the development and construction of EWS houses under Light House Projects in six states at selected site

under Global Housing Technology Challenge-India (GHTC-INDIA)". The proposal shall be submitted in Room No. 118-G, NBO Building, Nirman Bhawan, New Delhi in between 10.30 to 16:00 Hours and shall clearly mention name of Project, RFP No.

(ix) The bid shall comprise a single packet containing the "EMD in form of Bank Guarantee" and "Technical Proposal" for each location shall be placed in hard binding and the pages shall be numbered serially. The document shall clearly mention Name of Bidder, LHP location and Alternate Technology proposed. Each page thereof shall be initialed in blue ink by the authorized signatory. The Proposal shall be marked as Original on right hand corner of Cover page of proposal in RED ink along with required documents.

(x) It is also herewith informed that above mentioned RFP is being published on eprocure.gov.in for all six locations. During the process of evaluation of bid, all the conditions mentioned in RFP are not mutually exclusive and distinct. The participating agency(ies) are free to participate in the bidding process for more than one location using the same technology at different locations. Similarly, participating agency(ies) are free to participate in the bidding process for more than one location using the different technologies on different locations. However, in order to propagate the use of different alternate technologies across the regions, lowest Participating Agency with one of the shortlisted technologies would be allotted work in one region only using that specific technology .Once a particular technology)as distinct from technology provider (has been selected for one location, all the bids using the same technology for other locations shall not be opened. This will ensure that different locations will have separate technologies. Therefore, all the participating agency(ies) are requested to quote separately after downloading all published documents for all locations. Hence, MoHUA is publishing same RFP for all six locations with different template for financial bids. Participating agency(ies) is/are required to quote separately for different locations using same or different technology after using the different location wise financial template and upload the technical and financial proposals as per location mentioned

xi) All participating agency(ies) are requested to submit the proof of same EMD in all technical bids as mentioned in RFP if they are quoting for more than one location with same technology. Similarly, if one agency is applying for one or more technologies for different locations, separate proof of EMD shall be submitted in all technical bids.

ANNEXURE-A

Broad categories of Technologies

S. No.	Technology Provider
A. **Precast Concrete Construction System - 3D Precast volumetric**	
1	M/s Katerra India Pvt. Ltd.
2	M/s Moducast Pvt. Ltd.
3	M/s Magicrete Building Solutions
4	M/s Ultratech Cement Ltd.
B. **Precast Concrete Construction System - Precast components assembled at site**	
5	M/s Larsen & Toubro
6	M/s B.G. Shirke Construction Technology Pvt. Ltd.
7	M/s Elematic India
8	M/s PG Setty Construction Technology Pvt. Ltd.
9	M/s Teemage Builders Pvt. Ltd.
10	M/s Nordicflex House
11	M/s Adlakha Associates Pvt. Ltd.
12	M/s William Ling
C. **Light Gauge Steel Structural System & Pre-engineered Steel Structural System**	
13	M/s Mitsumi Housing Pvt. Ltd.
14	M/s Everest Industries Ltd.
15	M/s JSW Steel Ltd.
16	M/s Society for Development of Composites
17	M/s Elemente Designer Homes
18	M/s MGI Infra Pvt. Ltd.
19	M/s RCM Prefab Pvt. Ltd.
20	M/s Nipani Infra and Industries Pvt. Ltd.
21	M/s Strawcture Eco
22	M/s Visakha Industries Ltd.
23	M/s RCC Infra Ventures Ltd.
24	M/s Jindal Steel & Power Ltd.
25	M/s HIL Ltd.
26	M/s Biltech Building Elements Ltd.
27	M/s SCG International India Pvt. Ltd.
28	M/s Pioneer Precast Solutions Private Limited
D. **Prefabricated Sandwich Panel System**	
29	M/s Worldhaus
30	M/s Bhargav Infrastructure Pvt.Ltd.
31	M/s Rising Japan Infra Private Limited
32	M/s Bau Panel Systems India Pvt. Ltd .
33	M/s BK Chemtech Engineering

S. No.	Technology Provider
34	M/s MSN Construction
35	M/s Beardshell Ltd.
36	M/s Covestro India Pvt. Ltd.
37	M/s Project Etopia Group
E. **Monolithic Concrete Construction**	
38	M/s Maini Scaffold Systems Pvt. Ltd.
39	M/s KumkangKind India Pvt. Ltd.
40	M/s S-form India Pvt. Ltd.
41	M/s ATS Infrastructure Ltd.
42	M/s Innovative housing & Infrastructure Pvt. Ltd.
43	M/s MFS formwork Systems Pvt. Ltd.
44	M/s Knest Manufacturers LLP.
45	M/s Outinord Formworks Pvt. Ltd.
46	M/s Brilliant Etoile
F. **Stay In Place Formwork System**	
47	M/s JK Structure
48	M/s FACT RCF Building Products Limited
49	M/s Coffor Construction Technology Pvt.Ltd
50	M/s Joseph Jebastin (Novel Assembler Private Limited),
51	M/s Reliable InsupackBuilding Solutions
52	M/s Kalzen Realty Pvt. Ltd.
53	M/s Fastbloc Building Systems
54	M/s FTS BuildtechPvt.Ltd.

AAI	Airport Authority of India
BIM	Building Information Management
BIS	Bureau of Indian Standards
BSES	Local DISCOM
C & D Waste	Construction & Demolition Waste
COA	Council of Architecture
CPI	Consumer Price Index
CPWD	Central Public Works Department
DBR	Design Basis Report
DLP	Defects Liability Period
DSR	Delhi Schedule of Rates
EM	Earnest Money
EPC	Engineering Procurement Construction
CC	Contract Conditions
GPRA	General Pool Residential Accommodation
GRIHA	Green Rating for Integrated Habitat Assessment
HSE	Health Safety & Environment
IGBC	Indian Green Building Council
IPC	Interim Payment Certificate
IS	Indian Standard
MAS	Material at Site
MEP	Mechanical Electrical Plumbing
MoHUA	Ministry of Housing and Urban Affairs
MT	Metric Ton
MTC	Material Testing Certificate
NBC	National Building Code
NGT	National Green Tribunal
NIT	Notice Inviting Bid
OEM	Original Equipment Manufacturer
PPE	Personal Protection Equipment
SAP	Safety Action Plan
SOP	Schedule of Payment
SOQ	Schedule of Quantities
STP	Sewage Treatment Plant
TDS	Tax Deduction at Source
TPQAA	Third Party Quality Assurance Agency
UTTIPEC	Unified traffic & transportation infrastructure (plg. &engg.) Centre
WPI	Wholesale Price Index
WTP	Water Treatment Plant

Section-I

SCOPE OF WORK (GENERAL)

The scope of work includes architectural design, structural design, and detailed drawings of all required services for commencement of works, execution of work & services and handing over the assets after making them habitable in all aspects. The scope is inclusive of topographic survey, subsoil investigation and all ancillary works. The cost of labor, material, tools and plants and machinery required for execution of the whole project as per approved Layout plan & detailed design and drawings is within the scope of this work. The work is to be executed on EPC basis.

The brief scope of work is as follows:

i) Architectural designing and obtaining all statutory/local body approvals required to start construction work as per built-up areas/ covered area given below:

Description	**Carpet area to be constructed**
A) No. of Houses- with necessary services as given below: i.) Lucknow, Uttar Pradesh ii.) Ranchi, Jharkhand iii.) Agartala, Tripura iv.) Indore, Madhya Pradesh v.) Rajkot, Gujarat vi.) Chennai, Tamil Nadu	As defined earlier in the RFP document.
B) Proposed Social Infrastructural Facilities	As defined earlier in the RFP document.

ii) The general parameters of Architectural Designing:

Description	Permissible
Total Plot Area	As defined earlier in the RFP document
Carpet area per Unit	
Number of Storeys	
FAR proposed	
Proposed Number of Units	

iii) The Layout Plan and Unit designs as attached as Section G forming part of this document are suggestive. The unit designs and layout plans may slightly deviate as per the technology requirement with the approval of MoHUA.

iv) Conducting all studies as per the requirement at site such as :

a. Topographical survey, Sub-soil investigation
b. EIA, its clearance & compliance
c. Others as per required

v) Design of all Architectural, Civil/ Structural, Electrical & mechanical

and Horticulture Services their integration and installation commissioning, including preparation of construction drawings, shop drawings, conducting necessary surveys and field tests to facilitate designing process, facilitate approval from MoHUA, construct the housing as per drawings approved by MoHUA.

vi) Development of area, construction of boundary wall, internal roads, Street lighting, Parks and other amenities etc. required for safe living.

vii) The location plan, site layout and other related Architectural drawings is attached in this document as Section G.

Section-II

INFORMATION AND GUIDELINES FOR PARTICIPATING AGENCY

1.0 General:

1.1 Letter of transmittal and forms for deciding eligibility are given in Section III.

1.2 All information called for in the enclosed forms should be furnished against the relevant columns in the forms. If for any reason, information is furnished on a separate sheet, this fact should be mentioned against the relevant column. Even, if no information is to be provided in a column, a **'nil'** or **'no such case'** entry should be made in that column. If any particulars/query is not applicable in case of the participating agency, it should be stated as **'Not applicable'**. The Participating Agency are cautioned that not giving complete information called for in the application forms or not giving it in clear terms or making any change in the prescribed forms (or) deliberately suppressing the information may result in the bid being summarily disqualified. Bid made by telegram or telex and those received late will not be entertained.

1.3 The Technical bid should be in English. The participating agency should sign on each page of application, forms and documents before scanning & uploading and to ensure proper numbering and indexing.

1.4 Corrections if any should be made by neatly crossing out, initialing, dating and rewriting. Pages of the eligibility criteria document are numbered. Additional Sheets if any added by the Participating agency should also be numbered by him. They should be submitted as a package with signed letter of transmittal. Over writing should be avoided.

1.5 References, information and certificate from the respective clients certifying suitability, technical knowledge or capability of the participating agency should be signed by an authorized officer.

1.6 The participating agency may furnish any additional information, which he thinks is necessary to establish his capabilities to successfully complete envisaged work. He is, however advised not to furnish superfluous information. No information shall be entertained after submission of eligibility criteria document unless it is called for by the MoHUA.

1.7 If private works are shown in support of eligibility, certified copy of the TDS shall be submitted along with the experience certificate and the TDS amount shall tally with the actual amount of work done.

1.8 All participating agencies as a single entity or in JV/ Consortium have to meet all eligibility conditions mentioned in RFP comprehensively otherwise bid submitted will be rejected.

1.9 Two or more shortlisted technology providers as mentioned in Annexure A cannot collectively form a consortium/ JV

2.0 Final Decision Making Authority:

The MoHUA reserves the right to accept or reject any bid and to annul the process and reject all bids at any time without assigning any reason or incurring any liability to the participating agency's.

3.0 Addendum/ Corrigendum

Addendum/Corrigendum to the bid documents may be issued prior to the date of submission of the bid to clarify or effect modification in specification and/or contract terms included in various bid documents. The Participating agency shall suitably take into consideration such Addendum/Corrigendum while submitting his bid. The Participating agency shall return such Addendum/Corrigendum duly signed and stamped as confirmation of its receipt & acceptance and submit along with the bid document. All Addendum/Corrigendum shall be signed and stamped on each page by the Participating agency and shall become part of the bid and contract documents.

4.0 Site Visit:

It is incumbent upon the participating agency to visit the site at his own cost, and examine it and its surroundings by himself collect all information that is considered necessary for proper assessment, planning, design and construction of the project.It is expected that while bidding, the participating agency will take utmost care and diligence by visiting the sites and collecting the required parameters necessary. In case of any discrepancies later, MoHUA will not be held responsible. Contact persons of six locations are as follows:

S. No.	**LHP-City, State**	**Name and Designation of Nodal Officer appointed by concerned State**	**Contact Information of Nodal Officer**
1	Rajkot, Gujarat	Shri B.N. Patel, Project Specialist, Chief Engineer, Affordable Housing Mission	9978407349 (Bhavin Patel)
2	Ranchi, Jharkhand	Shri Rajeev Ranjan, I.A.S, Director/ Shri Sanjay Pandey, Assistant Director, Directorate of Municipal Administration, Jharkhand	7903796154
3	Indore, Madhya Pradesh	Shri Rajnish Kasera, Additional Commissioner (PMAY), Nagar Palika Nigam, Indore	7440446100
4	Lucknow, Uttar Pradesh	Shri Atul Kumar Singh Chauhan, Senior PO, SUDA	9958689889
5	Chennai, Tamil Nadu	Shri Rajasekar, Chief Engineer, Tamil Nadu Slum Clearance Board	9843020610
6	Agartala, Tripura	Shri D. Chakraborty, Chief Engineer, Urban Development Department, Govt. of Tripura	8837326330

5 Evaluation Criteria:

5.1 The details submitted by the participating agency will be evaluated in the following manner:-

5.1.1 The initial criteria prescribed in the RFP in respect of experience of similar work experience, eligibility, solvency and financial strength etc., will first be scrutinized and the participating agency's eligibility for the project will be determined.

5.1.2 The participating agency's qualifying the initial criteria as mentioned above will be evaluated as per the criteria mentioned below by scoring method on the basis of details furnished by the participating agency (ies)-

a. Financial strength (Form 'A'& 'B')- **Max.25 marks**
b. Experience in similar nature of work during last 7 **years**(Form 'C')- **Max.25 marks**
c. Performance on works (Time over Run) (Form 'D') –**Max.10 marks**
d. Performance on works (Quality) (Form 'D')- **Max.20 marks**
e. Assessment in terms of Technical Competency, plant and machinery, consulting capabilities, approach to design and construction and work plan– **Max 20 marks**

Total **100 marks**

5.1.3 To become eligible for short listing and for opening the Financial Bid, the participating agency must secure at least **50% (Fifty percent)** marks in each category and **60% (Sixty percent**) marks in aggregate.

5.1.4 MoHUA, however reserves the right to restrict the list of such qualified Participating Agency to any number deemed suitable by it.

5.1.5 After evaluation of Technical Bids, Financial Bids will be opened only of technically qualified participating agencies as per the criteria defined above and the work will be awarded to the lowest quoted (L1) participating agencies.

Note: The average value of performance of works for time over run and quality shall be taken on the basis of performance report of the eligible similar works.

1.0 **Financial Information**:

Participating agency should furnish the following financial information:

i. Annual financial statement for the last Five years in Form 'A' and
ii. Solvency certificate in Form 'B'

7.0 **Experiences in Works Highlighting Experience in Similar Works:**

7.1 Participating agency should furnish the following:

i. List of all works of similar nature successfully completed during last **Seven years** in Form 'C'

ii. Performance reports (corresponding to work mentioned in (Form-C) in Form-D. If needed, the participating agency may attach a separate certificate in this regard from performance report issuing authority.

8.0 **Organization Information:**

8.1 Participating agency is required to submit the information in respect of his/her/their organization in Form- 'E'.

8.1.1 The participating agency should have sufficient number of Technical and Administrative employees for proper execution of the contract. The participating agency should have to submit a list of these employees stating clearly how these would be involved in this work within 15 days of award of work.

9.0 Construction Plant and Equipment:

The Participating agency should furnish the list of construction plant and equipment required to be used in carrying out the work.

10.0 Letter of Transmittal:

The Participating agency should submit the letter of transmittal attached with the document.

11.0 Opening of Financial Bid:

After evaluation of pre-qualification documents, a list of short listed agencies who qualifies in technical bids will be prepared. There after the financial bids of only the qualified and technically acceptable Participating Agency shall be opened at the notified time, date and place in the presence of the qualified Participating Agency or their representatives if they desire to be present. The bid shall remain **valid for 120 days** from the date of opening of Technical bid (eligibility bid).

12.0 Award criteria:

12.1 The MoHUA reserves the right, without being liable for any damages or obligation to inform the participating agency to:

12.1.1 Amend the scope and value of contract to the participating agency.

12.1.2 Reject any or all the applications without assigning any reason.

12.1.3 Any effort on the part of the participating agency or his agent to exercise influence or to pressurize the MoHUA would result in rejection of his bid. Canvassing of any kind is prohibited.

ANNEXURE-II

Criteria for Evaluation of the performance of participating agency for Pre- Eligibility

<table>
<tr><td>S. No</td><td>Attributes</td><td>Max. Marks</td><td colspan="5">Evaluation</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Financial Strength

(Maximum 25 Marks)</td><td>20 Marks</td><td colspan="5">1. Average Financial Turnover of last five consecutive years (fiscal) should be minimum 60 Cr</td></tr>
<tr><td>05 Marks</td><td colspan="5">2. Solvency Certificate of at least 40% of estimated project cost (each location)(Certification from Nationalized bank/ any Scheduled bank)</td></tr>
<tr><td>2.</td><td>Past Experience in similar work (Maximum 25 Marks)</td><td>25 marks</td><td colspan="5">1. Six (6) Project – 25 Marks
2. Less than Six (6) but more than Three (3) projects – 20 Marks
3. Less than or equal Three (3) projects – 15 Marks</td></tr>
<tr><td>3.</td><td colspan="7">Performance on works
[Time Over Run (TOR)]: Maximum 10 marks</td></tr>
<tr><td></td><td>Parameter</td><td>Calculation for points</td><td colspan="4">Score</td><td>Maximum Marks</td></tr>
<tr><td rowspan="5"></td><td rowspan="5">If TOR =
(i) Without levy of compensation
(ii) With levy of compensation
(iii) Levy of compensation not decided</td><td colspan="2">1.00</td><td>2.00</td><td>3.00</td><td>>3.50</td><td rowspan="5">10</td></tr>
<tr><td colspan="2">10</td><td>7.5</td><td>5</td><td>5</td></tr>
<tr><td colspan="2">10</td><td>2.5</td><td>0</td><td>0</td></tr>
<tr><td colspan="2">10</td><td>5</td><td>0</td><td>0</td></tr>
<tr><td></td><td colspan="7">TOR = AT/ST, where AT =Actual Time; ST= Stipulated Time.
Note: Marks for value in between the stages indicated above is to be determined by straight line variation basis.</td></tr>
<tr><td>4</td><td colspan="7">Performance of works (Quality): Maximum 20 Marks</td></tr>
<tr><td></td><td colspan="2">(i) Outstanding</td><td colspan="5">20 Marks</td></tr>
<tr><td></td><td colspan="2">(ii) Very Good</td><td colspan="5">15 Marks</td></tr>
<tr><td></td><td colspan="2">(iii) Good</td><td colspan="5">10 Marks</td></tr>
<tr><td></td><td colspan="2">(iv) Poor</td><td colspan="5">0 Marks</td></tr>
<tr><td>5</td><td colspan="7">Assessment in terms of Technical Competency, plant and machinery, consulting capabilities, approach to design and construction with work plan: Max 20 Marks
(Attach the list of technical staffs, existing consultation partners, plant and machinery details, geographical presence and other moveable and immovable assets)</td></tr>
</table>

	(i) Technical staffs, existing consultation partners	05 Marks
	(ii)Plant and machinery details	05 Marks
	(iii) Geographical presence and other moveable and immovable assets	05 Marks
	(iv) Approach to design and construction, work plan based on design philosophy mentioned in scope of work	05 Marks
Grand Total		**100 Marks**

SECTION-III: TEMPLATE OF FORMS

LETTER OF TRANSMITTAL

From

To

.....

Name of Work:

Sir,

Having examined details given in the RFP for the above work, I/we hereby submit the relevant information.

1. I/We hereby certify that all the statements made and information supplied in the enclosed Forms A to I and accompanying statement are true and correct.

2. I/we have furnished all information and details necessary for eligibility and have no further pertinent information to supply.

3. I/we submit the requisite certified solvency certificate and authorize the **.....**to approach the Bank issuing the solvency certificate to confirm the correctness thereof. I/We also authorize **.....**to approach individuals, MoHUA, firms and corporation to verify our competence, work experience, and general reputation.

I/we submit the following certificates in support of our suitability, technical knowledge and capability for having successfully completed the following works:

Certificate

It is certified that the information given in the enclosed eligibility bid are correct. It is also certified that I/We shall be liable to be debarred, disqualified/cancellation of enlistment in case any information furnished by me/us found to be incorrect.
Enclosures:

Date of submission

Seal of participating agency&
Signature(s)
of participating agency(s)

FORM 'A'

FINANCIAL INFORMATION

Name of the firm/Participating agency……:

I. Financial Analysis-Details to be furnished duly supported by figures in balance sheet/profit & loss account for the last five years duly certified and audited by the Chartered Accountants, as submitted by the applicant to the Income Tax Department (Copies to be attached).

Rs.in Lakh

Sl. No.	**Particulars**	**Financial Years**				
i)	Turnover of construction works	2014-15	2015-16	2016-17	2017-18	2018-19
ii)	Profit/ Loss					

II. Financial arrangements for carrying out the proposed work.

III. Solvency Certificate from Bankers of participating agency in the prescribed Form "B"

SIGNATURE OF PARTICIPATING AGENCY(S)
Signature of Chartered Accountant with Seal

FORM 'B'

FORM OF BANKERS' SOLVENCY CERTIFICATE FROM A SCHEDULED BANK

This is to certify that to the best of our knowledge and information that M/s./Shri …….. having marginally noted address, a customer of our bank are/is respectable and can be treated as good for any engagement up to a limit of Rs ------- …….).

This certificate is issued without any guarantee or responsibility on the bank or any of the officers.

(Signature) For the Bank

NOTE: (1) Bankers certificate should be on letter head of the Bank, addressed to MoHUA……
(2) In case of partnership firm, certificate should include names of all partners as recorded with the Bank.

FORM 'C'

DETAILS OF ELIGIBLE SIMILAR NATURE OF WORKSCOMPLETED IN LAST SEVEN YEARS ENDING PREVIOUS DAY OF LAST DATE OF SUBMISSION OF BID

Name of the firm/Participating agency.....

S.No.	Details
1.	Name of work/project and location
2.	Owner or sponsoring organization
3.	Cost of work in Rs. in Crores
4.	Date of commencement as per contract
5.	Stipulated date of completion
6.	Actual date of completion
7.	*Litigation/arbitration cases pending/in progress with details
8.	Name and Address (Postal & E-mail)/telephone number of officer to whom reference may be made
9.	Whether the work was done on back to back basis

Certified that the above list of works is complete and no work has been left out and that the information given is correct to my/our knowledge and belief.

SIGNATURE OF PARTICIPATING AGENCY(S)

WITH STAMP

***indicate gross amount claimed and amount awarded by the Arbitrator.**

FORM 'D'

PERFORMANCE REPORT OF WORKS REFERRED IN FORM-C

1.	Name of work/Project & Location		
2.	Agreement No.		
3.	Estimated Cost		
4.	Bided Cost		
5.	Date of Start		
6.	Date of completion		
	i)	Stipulated Date of Completion (as mentioned in work order)	
	ii)	Actual Date of Completion	
7.	i)	Whether case of levy of compensation for delay has been decided or not	Yes/ No.
	ii)	If decided, amount of compensation levied for delayed completion, if any.	
8.	Performance Report		
	1) Quality of Work		Outstanding/Very Good/Good/Poor
	2) Financial Soundness		Outstanding/Very Good/ Good/Poor
	3) Technical Proficiency		Outstanding/Very Good/ Good/Poor
	4) Resourcefulness		Outstanding/Very Good/ Good/Poor
	5) General Behavior		Outstanding/Very Good/ Good/ Poor
Dated:			**Competent Authority**

Note: This certificate should be issued by the owner of the project. However, the quality and performance shall be established by the committee constituted by MoHUA by conducting site visits to the selected project sites

FORM 'E'

STRUCTURE & ORGANIZATION

1.	Name & Address of the participating agency		
2.	Telephone No. / Email id /Telex No./Fax No.		
3.	Legal status of the participating agency(attach copies of original document defining the legal status).		
	a)	A Business Entity	
	b)	A Proprietary Firm	
	c)	A Firm in Partnership	
	d)	A Limited Company or Corporation	
4.	Particulars of registration with various Government bodies (attach attested photo-copy).		
	ORGANIZATION/PLACE OF REGISTRATION		REGISTRATION No.
	1.		
	2.		
	3.		
5.	Names and Titles of Directors & Officers with designation to be concerned with this work.		
6.	Designation of individuals authorized to act for the organization.		
7.	Has the participating agency or any constituent partner in case of partnership firm, ever abandoned the awarded work before its completion? If so, give name of the project and reasons for abandonment.		
8.	Has the participating agency, or any constituent partner in case of partnership firm/limited company/ joint venture, ever been convicted by the court of law? If so, give details.		
9.	In which field of Civil Engineering Construction, the participating agency has specialization and interest?		
10.	Any other information considered necessary but not included above.		

Signature of participating agency(s) with stamp

FORM 'F'

EMD RECEIPT FORMAT

Receipt of deposition of original Bank Guarantee as EMD

Receipt No.....*..... /date.....*.....

Name of Work:

1. **RFP No:**
2. **Amount of Earnest Money Deposit:**
   i) In the form of Bank Guarantee Rs.....issued by..... .... Date....(as per Form- G)
3. **Last date of submission of bid:**

---

1. **Name of Participating agency:** .....#
2. **Total EMD Deposited:** ..... #
3. **Amount of Earnest Money Deposit:** ..... #
   i) In the form of Bank Guarantee Rs.....issued by..... .... Date....(as per Form- G)
4. **Date of submission of EMD:**.....#

Signature, Name and Designation of EMD receiving officer
(Along with Office stamp)

Form-G

FORM OF EARNEST MONEY DEPOSIT (BANK GUARANTEE BOND)

WHEREAS, participating agency..... (Name of Participating agency) (herein after called "the Participating agency") has submitted his bid dated ..... (date) for the construction of ..... (name of work) (herein after called "the bid")

KNOW ALL PEOPLE by these presents that we ..... (name of bank) having our registered office at ..... (herein after called "the Bank") are bound unto **.....(name of office)** in the sum of Rs. ..... (Rs. in words .....) for which payment well and truly to be made to the said **.....(name of beneficiary),** the Bank binds itself, his successors and assigns by these presents.

SEALED with the Common Seal of the said Bank this ..... day of ..... 2.... THE CONDITIONS of this obligation are:

(1) If after bid opening ..... of bid; the Participating agency withdraws, his bid during the period of validity of bid (including extended validity of bid) specified in the Form of Bid;

(2) If the Participating agency having been notified of the acceptance of his bid by the .....

(a) Fails or refuses to execute the Form of Agreement in accordance with the Instructions to Participating agency, if required;

OR

(b) Fails or refuses to furnish the Performance Guarantee, in accordance with the provisions of bid document and Instructions to Participating agency,

We undertake to pay to the either up to the above amount or part thereof upon receipt of his first written demand, without the **.....** having to substantiates his demand, provided that in his demand **.....** will note that the amount claimed by him is due to him owing to the occurrence of one or any of the above conditions, specifying the occurred condition or conditions.

This Guarantee will remain in force up to and including the date * after the deadline for submission of bid as such deadline is stated in the Instructions to Participating agency or as it may be extended by the **.....,** notice of which extension(s) to the Bank is hereby waived. Any demand in respect of this Guarantee should reach the Bank not later than the above date.

DATE ..... **SIGNATURE OF THE BANK**

WITNESS ..... **SEAL**

(SIGNATURE, NAME AND ADDRESS)

*Date to be worked out on the basis of validity period of 6 months from the last date of uploading the bid.

Form-H

AFFIDAVIT

(To be submitted by bidder on non-judicial stamp paper of Rs.100/(Rupees Hundred only) duly attested by Notary Public)

Affidavit of Mr. .....S/o .....
R/o .....

I, the deponent above named do hereby solemnly affirm and declare as under:

1. That I am the Proprietor/Authorized signatory of M/s ..... Having its Head Office/Regd. Office at .....

2. That the information/documents/Experience certificates submitted by M/s..... along with the tender for ..... *(Name of work*).....
   To MoHUA are genuine and true and nothing has been concealed.

3. I shall have no objection in case MoHUA verifies them from issuing authority(ies). I shall also have no objection in providing the original copy of the document(s), in case MoHUA demands so for verification.

4. I hereby confirm that in case, any document, information & / or certificate submitted by me found to be incorrect / false / fabricated, MoHUA at its discretion may disqualify / reject / terminate the bid/contract and also forfeit the EMD / All dues.

5. I shall have no objection in case MoHUA verifies any or all Bank Guarantee(s) under any of the clause(s) of Contract including those issued towards EMD and Performance Guarantee from the Zonal / Branch office of issuing Bank and I/We shall have no right or claim on my submitted EMD before MoHUA receives said verification.

6. That the Bank Guarantee issued against the EMD issued by (name and address of the Bank) is genuine and if found at any stage to be incorrect / false / fabricated, MoHUA shall reject my bid, cancel pre-qualification and debar me from participating in any future tender for three years.

7. I hereby confirm that our firm /company is not blacklisted/ barred /banned from tendering by MoHUA. If this information is found incorrect, MoHUA at its discretion may disqualify / reject / terminate the bid/contract.

8. The person who has signed the tender documents is our authorized representative. The Company is responsible for all of his acts and omissions in the tender.

I, ..., the Proprietor / Authorised signatory of M/s..... do hereby confirm that the contents of the above Affidavit are true to my knowledge and nothing has been concealed there from..... and that no part of it is false.

DEPONENT

Verified at .....this.....day of .....

DEPONENT

ATTESTED BY (NOTARY PUBLIC)

FORM-I

GST Registration Details of Contractor/Vender	
Name	
Address (As per registration with GST)	
City	
Postal Code	
Region/State (Complete State Name)	
Permanent Account Number	
GSTIN ID/Provisional ID No.: (copy of Acknowledgement required)	
Type of Business (As per registration with GST)	
Service Accounting Code/HSN Code:	
Contact Person	
Phone Number and Mobile Number	
Email ID	
Compliance Rating (if updated by GSTN)	

ANNEXURE-III

INTEGRITY PACT

To,
……,
……

Sub: Submission of Bid for the work of ……

Dear Sir,

I/We acknowledge that MoHUA is committed to follow the principles thereof as enumerated in the Integrity Agreement enclosed with the bid/bid document.

I/We agree that the RFP is an invitation to offer made on the condition that I/We will sign the enclosed integrity Agreement, which is an integral part of bid documents, failing which I/We will stand disqualified from the biding process. I/We acknowledge that THE MAKING OF THE BID SHALL BE REGARDED AS AN UNCONDITIONAL AND ABSOLUTE ACCEPTANCE of this condition of the RFP.

I/We confirm acceptance and compliance with the Integrity Agreement in letter and spirit and further agree that execution of the said Integrity Agreement shall be separate and distinct from the main contract, which will come into existence when bid/bid is finally accepted by MoHUA. I/We acknowledge and accept the duration of the Integrity Agreement, which shall be in the line with Article 1 of the enclosed Integrity Agreement.

I/We acknowledge that in the event of my/our failure to sign and accept the Integrity Agreement, while submitting the bid/bid, MoHUA shall have unqualified, absolute and unfettered right to disqualify the Participating agency/participating agency and reject the bid/bid is accordance with terms and conditions of the bid/ bid.

Yours faithfully

(Duly authorized signatory of the Participating agency)

INTEGRITY AGREEMENT

(To be signed by the participating agency and same signatory competent / authorized to sign the relevant contract on behalf of MoHUA)

.

This Integrity Agreement is made at ..... on this..... day of ..... 20.....

BETWEEN

.....,
....., (Name of Office) MoHUA,
.....,
(Hereinafter referred as the 'Principal/Owner', which expression shall unless repugnant to the meaning or context hereof include its successors and permitted assigns)

AND

.....
..... (Name and Address of the Individual/firm/Company) through .....
(Hereinafter referred to as the (Details of duly authorized signatory) "Participating agency/Participating agency" and which expression shall unless repugnant to the meaning or context hereof include its successors and permitted assigns)

Preamble

WHEREAS the Principal / Owner has floated the Bid (RFP No. .....) (hereinafter referred to as "Bid/Bid") and intends to award, under laid down organizational procedure, contract for .....
..... (Name of work)
hereinafter referred to as the "Contract".

AND WHEREAS the Principal/Owner values full compliance with all relevant laws of the land, rules, regulations, economic use of resources and of fairness/transparency in its relation with its Participating agency(s) and Participating agency(s).

AND WHEREAS to meet the purpose aforesaid both the parties have agreed to enter into this Integrity Agreement (hereinafter referred to as "Integrity Pact" or "Pact"), the terms and conditions of which shall also be read as integral part and parcel of the Bid/Bid documents and Contract between the parties.

NOW, THEREFORE, in consideration of mutual covenants contained in this Pact, the parties hereby agree as follows and this Pact witnesses as under:

Article 1: Commitment of the Principal/Owner

(1)MoHUA commits itself to take all measures necessary to prevent corruption and to observe the following principles:

(a) No employee of the Principal/Owner, personally or through any of his/her family members, will in connection with the Bid, or the

execution of the Contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.

(b) MoHUA will, during the Bid process, treat all Participating agency(s) with equity and reason. MoHUA will, in particular, before and during the Bid process, provide to all Participating agency(s) the same information and will not provide to any Participating agency(s) confidential / additional information through which the Participating agency(s) could obtain an advantage in relation to the Bid process or the Contract execution.

The Principal/Owner shall endeavor to exclude from the Bid process any person, whose conduct in the past has been of biased nature.

(2) If MoHUA obtains information on the conduct of any of its employees which is a criminal offence under the Indian Penal code (IPC)/Prevention of Corruption Act, 1988 (PC Act) or is in violation of the principles herein mentioned or if there be a substantive suspicion in this regard, the Principal/Owner will inform the Chief Vigilance Officer/Competent Authority and in addition can also initiate disciplinary actions as per its internal laid down policies and procedures.

Article 2: Commitment of the Participating agency(s)/Participating agency(s)

(1) It is required that each Participating agency/Participating agency (including their respective officers, employees and agents) adhere to the highest ethical standards, and report to the Government / Department all suspected acts of fraud or corruption or Coercion or Collusion of which it has knowledge or becomes aware, during the biding process and throughout the negotiation or award of a contract.

(2) The Participating agency(s)/Participating agency(s) commits himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the Bid process and during the Contract execution:

(a) The Participating agency(s)/Participating agency(s) will not, directly or through any other person or firm, offer, promise or give to any of the Principal/Owner's employees involved in the Bid process or execution of the Contract or to any third person any material or other benefit which he/she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the Bid process or during the execution of the Contract.

(b) The Participating agency(s)/Participating agency(s) will not enter with other Participating agency(s) into any undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to cartelize in the bidding process.

(c) The Participating agency(s)/Participating agency(s) will not commit any offence under the relevant IPC/PC Act. Further the Participating agency(s)/ Contract(s) will not use improperly, (for the purpose of competition or personal gain), or pass on to others, any information or

documents provided by the Principal/Owner as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

(d) The Participating agency(s)/Participating agency(s) of foreign origin shall disclose the names and addresses of agents/ representatives in India, if any. Similarly Participating agency(s)/Participating agency(s) of Indian Nationality shall disclose names and addresses of foreign agents/representatives, if any. Either the agent on behalf of the foreign principal or the foreign principal directly could bid in a bid but not both. Further, in cases where an agent participate in a bid on behalf of one manufacturer, he shall not be allowed to quote on behalf of another manufacturer along with the first manufacturer in a subsequent/parallel bid for the same item.

(e) The Participating agency(s)/Participating agency(s) will, when presenting his bid, disclose any and all payments he has made, is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the Contract.

(3) The Participating agency(s)/Participating agency(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

(4) The Participating agency(s)/Participating agency(s) will not, directly or through any other person or firm indulge in fraudulent practice means a willful misrepresentation or omission of facts or submission of fake/forged documents in order to induce public official to act in reliance thereof, with the purpose of obtaining unjust advantage by or causing damage to justified interest of others and/or to influence the procurement process to the detriment of the Government interests.

(5) The Participating agency(s)/Participating agency(s) will not, directly or through any other person or firm use Coercive Practices (means the act of obtaining something, compelling an action or influencing a decision through intimidation, threat or the use of force directly or indirectly, where potential or actual injury may befall upon a person, his/ her reputation or property to influence their participation in the biding process).

Article 3: Consequences of Breach

Without prejudice to any rights that may be available to the Principal/Owner under law or the Contract or its established policies and laid down procedures, the Principal/Owner shall have the following rights in case of breach of this Integrity Pact by the Participating agency(s)/Participating agency(s) and the Participating agency/ Participating agency accepts and undertakes to respect and uphold the Principal/Owner's absolute right:

(1) If the Participating agency(s)/Participating agency(s), either before award or during execution of Contract has committed a transgression through a violation of Article 2 above or in any other form, such as to put his reliability or credibility in question, the Principal/Owner after giving 14 days notice to the participating agency shall have powers to disqualify the

Participating agency(s)/Participating agency(s) from the Bid process or terminate/determine the Contract, if already executed or exclude the Participating agency/Participating agency from future contract award processes. The imposition and duration of the exclusion will be determined by the severity of transgression and determined by the Principal/Owner. Such exclusion may be forever or for a limited period as decided by the Principal/Owner.

(2) Forfeiture of EMD/Performance Guarantee/Security Deposit: If the Principal/Owner has disqualified the Participating agency(s) from the Bid process prior to the award of the Contract or terminated/determined the Contract or has accrued the right to terminate/determine the Contract according to Article 3(1), the Principal/Owner apart from exercising any legal rights that may have accrued to the Principal/Owner, may in its considered opinion forfeit the entire amount of Earnest Money Deposit, Performance Guarantee and Security Deposit of the Participating agency/Participating agency.

(3) Criminal Liability: If the Principal/Owner obtains knowledge of conduct of a Participating agency or Participating agency, or of an employee or a representative or an associate of a Participating agency or Participating agency which constitutes corruption within the meaning of IPC Act, or if the Principal/Owner has substantive suspicion in this regard, the Principal/Owner will inform the same to law enforcing agencies for further investigation.

Article 4: Previous Transgression

(1) The Participating agency declares that no previous transgressions occurred in the last 5 years with any other Company in any country confirming to the anticorruption approach or with Central Government or State Government or any other Central/State Public Sector Enterprises in India that could justify his exclusion from the Bid process.

(2) If the Participating agency makes incorrect statement on this subject, he can be disqualified from the Bid process or action can be taken for banning of business dealings/ holiday listing of the Participating agency/Participating agency as deemed fit by the Principal/ Owner.

(3) If the Participating agency/Participating agency can prove that he has resorted/recouped the damage caused by him and has installed a suitable corruption prevention system, the Principal/Owner may, at its own discretion, revoke the exclusion prematurely.

Article 5: Equal Treatment of all Participating Agency/Participating agencies/Sub-participating agency(s)

(1) The Participating agency(s)/Participating agency(s) undertake(s) to demand from all sub participating agency a commitment in conformity with this Integrity Pact. The Participating agency/Participating agency shall be responsible for any violation(s) of the principles laid down in this agreement/Pact by any of its sub participating agency/sub-vendors.

(2) The Principal/Owner will enter into Pacts on identical terms as this one with all Participating Agency and Participating agency.

(3) The Principal/Owner will disqualify Participating Agency, who do not submit, the duly signed Pact between the Principal/ Owner and the participating agency, along with the Bid or violate its provisions at any stage of the Bid process, from the Bid process.

Article 6- Duration of the Pact

This Pact begins when both the parties have legally signed it. It expires for the Participating agency/Vendor five years after the completion of work under the contract or till the continuation of defect liability period, whichever is more and for all other Participating Agency, till the Contract has been awarded. If any claim is made/lodged during the time, the same shall be binding and continue to be valid despite the lapse of this Pacts as specified above, unless it is discharged/determined by the Competent Authority, MoHUA.

Article 7- Other Provisions

(1) This Pact is subject to Indian Law, place of performance and jurisdiction is the Head quarters of the Division of the Principal/Owner, who has floated the Bid.

(2) Changes and supplements need to be made in writing. Side agreements have not been made.

(3) If the Participating agency is a partnership or a consortium, this Pact must be signed by all the partners or by one or more partner holding power of attorney signed by all partners and consortium members. In case of a Company, the Pact must be signed by a representative duly authorized by board resolution.

(4) Should one or several provisions of this Pact turn out to be invalid; the remainder of this Pact remains valid. In this case, the parties will strive to come to an agreement to their original intensions.

(5) It is agreed term and condition that any dispute or difference arising between the parties with regard to the terms of this Integrity Agreement/ Pact, any action taken by the Owner/Principal in accordance with this Integrity Agreement/Pact or interpretation thereof shall not be subject to arbitration.

Article 8- LEGAL AND PRIOR RIGHTS

All rights and remedies of the parties hereto shall be in addition to all the other legal rights and remedies belonging to such parties under the Contract and/or law and the same shall be deemed to be cumulative and not alternative to such legal rights and remedies aforesaid. For the sake of brevity, both the Parties agree that this Integrity Pact will have precedence over the

Bid/Contact documents with regard any of the provisions covered under this Integrity Pact.

IN WITNESS WHEREOF the parties have signed and executed this Integrity Pact at the place and date first above mentioned in the presence of following witnesses:

.....
(For and on behalf of Principal/Owner)

.....
(For and on behalf of Participating agency/Participating agency)

WITNESSES:

1. .....
(signature, name and address)

2. .....
(signature, name and address)

Place: Dated :

PART-III

FINANCIAL BID

Government of India
Ministry of Housing and Urban Affairs

EPC & Contract for Works

Name of Work: _____
_____

(i) **To be uploaded on website: www.eprocure.gov.in**

(ii) **To be opened in the presence of Participating Agency who may be present in the office of JS&MD (HFA)**

BID

I/We have read and examined the notice inviting bid, including all documents and amendments up to the last date of submission of bids, clauses of contract, special conditions, bill of quantities & other documents and rules referred to in the contract conditions and all other contents in the bid document for the work.

I/We hereby bid for the execution of the work specified for MoHUA within the time specified in …….. viz., schedule of quantities and in accordance in all respect with the specifications, designs, drawing and instructions and contract conditions given in this document.

We agree to keep the bid open for one hundred twenty **(120) days** from the date of opening of technical bid and not to make any modification in its terms and conditions.

A copy of receipt of deposition of earnest money **Rs 2.5 Crore** in receipt Treasury Challan/Deposit at call Receipt of scheduled bank/Fixed Deposit receipt of scheduled bank/Demand Draft or pay order or Banker's cheque of scheduled bank/bank guarantee issued by a scheduled bank is scanned and uploaded. If I/We, fail furnish to the prescribed performance guarantee within prescribed period, I/We agree that the said President of India or his successors, in office shall without prejudice to any other right or remedy, be at liberty to forfeit the said Earnest Money absolutely. Further, if I/We fail to commence work as specified, I/We agree that President of India or the successors in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said performance guarantee absolutely, the said performance guarantee shall be a guarantee to execute all the works referred to in the bid documents upon the terms and conditions contained or referred to those in excess of that limit at the rates to be determined in accordance with the provision contained in clause 12.2 and 12.3 (as modified) of the bid form.

Further, I/We agree that in case of forfeiture of Earnest Money or Performance Guarantee as aforesaid, I/We shall be debarred for participation in the re-bidding process of the work.

I/we undertake and confirm that eligible similar work(s) has/have not been got executed through another agency on back to back basis. Further that, if such a violation comes to the notice of Department, then I/we shall be debarred for bidding in MOHUA in future forever. Also, if such a violation comes to the notice of Department before date of start of work, the Competent Authority shall be free to forfeit the entire amount of Earnest Money Deposited/Performance Guarantee.

I/We hereby declare that I/We shall treat the bid documents drawings and other records connected with the work as secret/confidential documents and shall not communicate information/derived there from to any person other than a person to whom I/We am/are authorized to communicate the same or use the information in any manner prejudicial to the safety of the State.

Dated: ..... **.....
Signature of Participating agency **

Witness: **

Address: ** **Postal Address ****

Occupation: **

[** to be filled by Participating agency]

ACCEPTANCE OF BID

The above bid (as modified by you as provided in the letters mentioned hereunder) is accepted by me for an on behalf of MoHUA for a sum of Rs……*…….
(Rupee……*……
……..).

The letters referred to below shall form part of this contract agreement: -

(a)
(b)
(c)

For & on behalf of MoHUA

Signature ……

Dated: ……. Designation ……

CONTRACT CONDITIONS

A. DEFINITIONS

The Contract means the documents forming the bid and acceptance thereof and the formal agreement executed between the competent authority on behalf of Ministry of Housing & Urban Affairs (MoHUA), GoI and the selected agency, together with the documents referred to therein including these conditions, the specifications, designs, drawings and instructions issued from time to time by MoHUA and all these documents taken together, shall be deemed to form one contract and shall be complementary to one another.

1.1 Ministry of Housing & Urban Affairs, GoI, hereinafter called 'MoHUA' propose to get the works executed as mentioned in the Contract as Implementing /Executing Authority.

1.2 In the contract, the following expressions shall, unless the context otherwise requires, have the meanings, hereby respectively assigned to them: -

a) MoHUA shall means Ministry of Housing & Urban Affairs, a Ministry of Government of India with its office at Nirman Bhawan, Maulana Azad Road, New Delhi or its Administrative officers or other employees authorized to deal with any matter with which these persons are concerned and authorized on its behalf.
b) COMPETENT AUTHORITY means the authorised representative declared by MoHUA who shall supervise and be in-charge of the work.
c) APPROVAL means approved in writing including subsequent written confirmation of previous verbal approval.
d) SCHEDULE OF QUANTITIES means the complete quantity statement forming or Schedule of Quantities forming part of the bid.
e) SELECTED AGENCY shall mean the individual, firm, LLP or company, whether incorporated or not, undertaking the works and shall include the legal personal representative of such individual or the persons composing such firm or LLP or company, or the successors of such firm or company and the permitted assignees of such individual, firm or company.
f) CONTRACT VALUE means the sum for which the bid is accepted as per the letter of Award.
g) DRAWINGS mean the drawings referred to in the contract document including modifications if any and such other drawings as may from time to time be furnished and/ or approved by MoHUA.
h) DATE OF COMMENCEMENT OF WORK: The date of start of contract shall be reckoned from the date of handing over of site and approvals.

i) LANGUAGE: All documents and correspondence in respect of this contract shall be in English Language.

j) "LETTER OF AWARD" shall mean MoHUA's letter or notification conveying its acceptance of the bid subject to such conditions as may have been stated therein.

k) MONTH means English Calendar month 'Day' means a Calendar day of 24 Hrs each.

l) OWNER/CLIENT means the MoHUA, Govt. of India who will be entering into the contract and getting the work executed.

m) SITE means the lands and other places on, under, in or through which the works are to be executed or carried out and any other lands or places provided by MoHUA or used for the purpose of the contract.

n) BID means the Selected agency's priced offer to MoHUA for the execution and completion of the work and the remedying of any defects therein in accordance with the provisions of the Contract, as accepted by the Letter of Award or Award letter. The word BID is synonymous with Bid and the word BID DOCUMENTS with "Biding Documents" or "offer documents".

o) WRITING means any manuscript typed, written or printed statement under or over signature and/or seal as the case may be.

p) Works or Work shall unless there be something either in the subject or context repugnant to such construction, be construed and taken to mean the works by or by virtue of the contract contracted to be executed whether temporary or permanent, and whether original, altered, substituted or additional.

q) Headings in the clauses/conditions of bid documents is for convenience only and shall not be used for interpretation of the clause/condition.

r) Words imparting the singular meaning only also include the plurals and vice versa where the context requires. Words importing persons or parties shall include firms and corporations and organizations having legal capacities.

s) Excepted Risk are risks due to riots (other than those on account of selected agency's employees), war (whether declared or not) invasion, act of foreign enemies, hostilities, civil war, rebellion revolution, insurrection, military or usurped power, any acts of Government, damages from aircraft, acts of God, such as earthquake, lightening and unprecedented floods, and other causes over which the selected agency has no control and accepted as such by the MoHUA.

t) Market Rate shall be the rate as decided by the Competent Authorityon the basis of the prevailing cost of materials and labour at the site where the work is to be executed plus the percentage mentioned elsewhere in the bid document to cover, all overheads and profits.

B. CLAUSES OF CONTRACT

1.0 Performance Guarantee

(i) The selected agency shall submit an irrevocable Performance Guarantee of 5% (Five percent) of the contract amount in addition to other deposits mentioned elsewhere in the contract for his proper performance of the contract agreement, (not withstanding and/or without prejudice to any other provisions in the contract) within 15 (fifteen) days from the date of issue of letter of acceptance. This Performance guarantee shall be in the form of bank guarantee from any scheduled bank/ commercial bank. The Performance Bank Guarantee shall be initially valid for 18 months from the issuance of award of contract plus 60 days beyond that. In case the time for completion of work gets enlarged, the selected agency shall get the validity of Performance Bank Guarantee extended to cover such enlarged time for completion of work. After recording of the completion certificate for the work by the competent authority, the Performance Bank Guarantee shall be returned to the selected agency, without any interest.

(ii) The Competent Authority shall not make a claim under the performance guarantee except for amounts to which MoHUA is entitled under the contract (not withstanding and/or without prejudice to any other provisions in the contract agreement) in the event of:

(a) Failure by the selected agency to extend the validity of the Performance Bank Guarantee as described herein above, in which event the Competent Authority may claim the full amount of the Performance Bank Guarantee.

(b) Failure by the selected agency to pay MoHUA any amount due, either as agreed by the selected agency or determined under any of the Clauses/Conditions of the agreement, within 30 days of the service of notice to this effect by Competent Authority.

(c) In the event of the contract being determined or rescinded under provision of any of the Clause/Condition of the agreement, the Performance Bank Guarantee shall stand forfeited in full and shall be absolutely at the disposal of MoHUA.

(d) On substantial Completion of any work which has been completed to such an extent that the intended purpose of the work is met and ready to use, then a provisional completion certificate shall be recorded by the Competent Authority. The provisional certificate shall have appended with a list of outstanding balance item of work that need to be completed in accordance with the provisions of the contract.

This provisional completion certificate shall be recorded by Competent Authority with the approval of MoHUA.

1A. Recovery of Security Deposit

The person/persons whose bid(s) may be accepted (hereinafter called the selected agency) shall permit MoHUA at the time of making any payment to selected agency for work done under the contract to deduct a sum at the rate of 5% of the gross amount of each running and final bill till the sum deducted will amount to security deposit of 5% of the contract value of the work. Such deductions will be made and held by Government by way of Security Deposit unless he/they has/have deposited the amount of Security at the rate mentioned above in the form of Government Securities or Fixed Deposit receipts. In case a Fixed Deposit receipt of any Bank is furnished by the selected agency to the Government as part of the Security Deposit and the Bank is unable to make payment against the said Fixed Deposit receipt, the loss caused thereby shall fall on the selected agency and the selected agency shall forthwith on demand furnish additional security to the Government to make good the deficit.

All compensations or the other sums of money payable by the selected agency under the terms of this contract may be deducted from, or paid by the sale of a sufficient part of his security deposit or from the interest arising there from, or from any sums which may be due to or may become due to the selected agency by Government on any account whatsoever and in the event of his Security Deposit being reduced by reason of any such deductions or sale as aforesaid, the selected agency shall within 10 days make good in cash or Fixed Deposit receipt bided by the State Bank of India or by scheduled Banks or Government Securities (if deposited for more than 12 months) endorsed in favour of the Competent Authority, any sum or sums which may have been deducted from, or raised by sale of his security deposit or any part thereof.

The Security Deposit shall be collected from the running bills and the final bill of the selected agency at the rates mentioned in the contract.

2.0 Compensation for Delay

If the selected agency fails to maintain the required progress or to complete the work and clear the site on or before the contract or justified extended date of completion, as per clause 5 (excluding any extension under Clause 5.5) as well as any extension granted under clauses 12 and 15, selected agency shall, without prejudice to any other right or remedy available under the law to the Government on account of such breach, pay as agreed compensation the amount calculated at the rates stipulated below as the authority MoHUA or their designee/representative may decide on the amount of Bided Value of the work for every completed day/month (as determined) that the progress remains below that specified in Clause 5 or that the work remains incomplete.

This will also apply to items or group of items for which a separate period of completion has been specified.

(i)	Compensation For delay of work	@ 1 % per month of delay to be computed on per day basis

Provided always that the total amount of compensation for delay to be paid under this Condition shall not exceed 10% of the contractvalue of work or of the contract value of the Sectional part of workfor which a separate period of completion is originally given.

Provided that compensation during the progress of work before the justified extended date of completion for delay under this clause shall be for non-achievement of sectional completion or part handing over of work on stipulated/justified extended date for such part work or if delay affects any other works/services. This is without prejudice to right of action by the Competent Authority under clause 3 for delay in performance and claim of compensation under that clause.

In case action under clause 2 has not been finalized and the work has been determined under clause 3, the right of action under this clause shall remain post determination of contract but levy of compensation shall be for days the progress is behind the schedule on date of determination, as assessed by MoHUA or their designee/representative after due consideration of justified extension. The compensation for delay, if not decided before the determination of contract, shall be decided after of determination of contract.

The amount of compensation may be adjusted or set-off against any sum payable to the selected agency under this or any other contract with the Government. In case, the selected agency does not achieve a particular milestone mentioned in this document or the re-scheduled milestone(s) in terms of Clause 5.4, the amount shown against that milestone shall be withheld, to be adjusted against the compensation levied as above. With-holding of this amount on failure to achieve a milestone, shall be automatic without any notice to the selected agency. However, if the selected agency catches up with the progress of work on the subsequent milestone(s), the withheld amount shall be released. In case the selected agency fails to make up for the delay in subsequent milestone(s), amount mentioned against each milestone missed subsequently also shall be withheld. However, no interest, whatsoever, shall be payable on such withheld amount.

3.0 When Contract can be Determined

Subject to other provisions contained in this clause, the Competent Authority may, without prejudice to his any other rights or remedy against the selected agency in respect of any delay, inferior workmanship, any claims for damages and/or any other provisions of

this contract or otherwise, and whether the date of completion has or has not elapsed, by notice in writing absolutely determine the contract in any of the following cases:

(i) If the selected agency having been given by the Competent Authority a notice in writing to rectify, reconstruct or replace any defective work or that the work is being performed in an inefficient or otherwise improper or poor workmanship shall omit to comply with the requirement of such notice for a period of seven days thereafter.

(ii) If the selected agency has, without reasonable cause, suspended the progress of the work or has failed to proceed with the work with due diligence and continues to do so after a notice in writing of seven days from the Competent Authority.

(iii) If the selected agency fails to complete the work or section of work with individual date of completion on or before the stipulated or justified extended date, on or before such date of completion; and the Competent Authority without any prejudice to any other right or remedy under any other provision in the contract has given further reasonable time in a notice given in writing in that behalf as either mutually agreed or in absence of such mutual agreement by his own assessment making such time essence of contract and in the opinion of Competent Authority the selected agency will be unable to complete the same or does not complete the same within the period specified.

(iv) If the selected agency persistently neglects to carry out his obligations under the contract and/or commits default in complying with any of the terms and conditions of the contract and does not remedy it or take effective steps to remedy it within 7 days after a notice in writing is given to him in that behalf by the Competent Authority.

(v) If the selected agency shall offer or give or agree to give to any person in Government service or to any other person on his behalf any gift or consideration of any kind as an inducement or reward for doing or forbearing to do or for having done or forborne to do any act in relation to the obtaining or execution of this or any other contract for Government.

(vi) If the selected agency shall enter into a contract with Government in connection with which commission has been paid or agreed to be paid by him or to his knowledge, unless the particulars of any such commission and the terms of payment thereof have been previously disclosed in writing to the Competent Authority.

(vii) If the selected agency had secured the contract with Government as a result of wrong biding or other non-bonafide methods of competitive biding or commits breach of Integrity Agreement.

(viii) If the selected agency being an individual, or if a firm, any partner thereof shall at any time be adjudged insolvent or have a receiving

order or order for administration of his estate made against him or shall take any proceedings for liquidation or composition (other than a voluntary liquidation for the purpose of amalgamation or reconstruction) under any Insolvency Act for the time being in force or make any conveyance or assignment of his effects or composition or arrangement for the benefit of his creditors or purport so to do, or if any application be made under any Insolvency Act for the time being in force for the sequestration of his estate or if a trust deed be executed by him for benefit of his creditors.

(ix) If the selected agency being a company shall pass a resolution or the court shall make an order that the company shall be wound up or if a receiver or a manager on behalf of a creditor shall be appointed or if circumstances shall arise which entitle the court or the creditor to appoint a receiver or a manager or which entitle the court to make a winding up order.

(x) If the selected agency shall suffer an execution being levied on his goods and allow it to be continued for a period of 21 days.

(xi) If the selected agency assigns, (excluding part(s) of work assigned to other agency(s) by the selected agency as per terms of contract), transfers, sublets (engagement of labour on a piece-work basis or of labour with materials not to be incorporated in the work, shall not be deemed to be subletting) or otherwise parts with or attempts to assign, transfer, sublet or otherwise parts with the entire works or any portion thereof without the prior written approval of the Competent Authority.

(xii) When the selected agency has made himself liable for action under any of the cases aforesaid, the Competent Authority on behalf of the President of India shall have powers:

(a) To determine the contract as aforesaid so far as performance of work by the selected agency is concerned (of which determination notice in writing to the selected agency under the hand of the Competent Authority shall be conclusive evidence). Upon such determination, the Earnest Money Deposit, Security Deposit already recovered and Performance Guarantee under the contract shall be liable to be forfeited and shall be absolutely at the disposal of the Government.

(b) After giving notice to the selected agency to measure up the work of the selected agency and to take such whole, or the balance or part thereof, as shall be un-executed out of his hands and to give it to another participating agency to complete the work. The selected agency, whose contract is determined as above, shall not be allowed to participate in the biding process for the balance work. In the event of above courses being adopted by the Competent Authority, the selected agency shall have no claim to compensation for any loss sustained by him by

reasons of his having purchased or procured any materials or entered into any engagements or made any advances on account or with a view to the execution of the work or the performance of the contract. And in case action is taken under any of the provision aforesaid, the selected agency shall not be entitled to recover or be paid any sum for any work thereof or actually performed under this contract unless and until the Competent Authority has certified in writing the performance of such work and the value payable in respect thereof and he shall only be entitled to be paid the value so certified.

4.0 Selected agency liable to pay Compensation even if action not taken under Clause 3

In any case in which any of the powers conferred upon the Competent Authority by Clause-3 thereof, shall have become exercisable and the same are not exercised, the non-exercise thereof shall not constitute a waiver of any of the conditions hereof and such powers shall notwithstanding be exercisable in the event of any future case of default by the selected agency and the liability of the selected agency for compensation shall remain unaffected. In the event of the Competent Authority putting in force all or any of the powers vested in him under the preceding clause he may, if he so desires after giving a notice in writing to the selected agency, take possession of (or at the sole discretion of the Competent Authority which shall be final and binding on the selected agency) use as on hire (the amount of the hire money being also in the final determination of the Competent Authority) all or any tools, plant, materials and stores, in or upon the works, or the site thereof belonging to the selected agency, or procured by the selected agency and intended to be used for the execution of the work/or any part thereof, paying or allowing for the same in account at the contract rates, or, in the case of these not being applicable, at current market rates to be certified by the Competent Authority, whose certificate thereof shall be final, and binding on the selected agency, clerk of the works, foreman or other authorized agent to remove such tools, plant, materials, or stores from the premises (within a time to be specified in such notice) and in the event of the selected agency failing to comply with any such requisition, the Competent Authority may remove them at the selected agency's expense or sell them by auction or private sale on account of the selected agency and his risk in all respects and the certificate of the Competent Authority as to the expenses of any such removal and the amount of the proceeds and expenses of any such sale shall be final and conclusive against the selected agency.

5.0 Time and Extension for Delay

The time allowed for execution of the Works or the extended time in accordance with these conditions shall be the essence of the Contract.

The execution of the works shall commence from such time period as mentioned in this document or from the date of handing over of the site notified by the Competent Authority, whichever is later. However, the handing over of site by the Competent Authority, in full or in part shall be completed within six months from issue of acceptance letter. If the selected agency commits default in commencing the execution of the work as aforesaid, the Performance Bank Guarantee shall be forfeited by the Competent Authority and shall be absolutely at the disposal of the Government without prejudice to any other right or remedy available in law. The time period for completion of the project will be extended with imposition of compensation for delay only.

5.1 As soon as possible but within twenty one days of award of work and statutory approvals in consideration of

a) Schedule of handing over of site

b) Schedule of issue of designs

(i) The selected agency shall submit a Time and Progress Chart for each mile stone. The Competent Authority may within 30 days thereafter, if required modify, and communicate the program approved to the selected agency failing which the program submitted by the selected agency shall be deemed to be approved by the Competent Authority. The work programme shall include all details of balance drawings and decisions required to complete the contract with specific dates by which these details are required by selected agency without causing any delay in execution of the work. The Chart shall be prepared in direct relation to the time stated in the contract documents for completion of items of the works. It shall indicate the forecast of the dates of commencement and completion of various trades of sections of the work and may be amended as necessary by agreement between the Competent Authority and the selected agency within the limitations of time imposed in the contract documents, and further to ensure good progress during the execution of the work, the selected agency shall in all cases in which the time allowed for any work, exceeds one month (save for special jobs for which a separate programme has been agreed upon) complete the work as per mile stones

(ii) In case of non-submission of construction programme by the selected agency the program approved by the Competent Authority shall be deemed to be final.

(iii) The approval by the Competent Authority of such programme shall not relieve the selected agency of any of the obligations under the contract.

(iv) The selected agency shall submit the time and progress chart and progress report using the mutually agreed software or in other format decided by Competent Authority for the work done during previous month to the Competent Authority on or before 5th day of each month.

5.2 If the work(s) be delayed by:-

(i) Force majeure, or

(ii) Abnormally bad weather, or

(iii) Serious loss or damage by fire, or

(iv) Civil commotion, local commotion of workmen, strike or lockout, affecting any of the trades employed on the work, or

(v) Delay on the part of other selected agency or tradesmen engaged by Competent Authority in executing work not forming part of the contract, or

(vi) Non-availability of stores, which are the responsibility of Government to supply or

(vii) Non-availability or break down of tools and Plant to be supplied or supplied by Government or

(viii) Any other cause like above which, in the reasoned opinion of the Competent Authority is beyond the selected agency's control.

Then upon the happening of any such event causing delay, the selected agency shall immediately give notice thereof in writing to the Competent Authority for entry in the hindrance register (physical or web-based but shall nevertheless use constantly his best endeavors to prevent or make good the delay and shall do all that may be reasonably required to the satisfaction of the Competent Authority to proceed with the works.

The selected agency shall have no claim of damages for extension of time granted or rescheduling of milestone/s for events listed in sub clause 5.2.

5.3 In case the work is hindered by any reasons, in the opinion of the selected agency, by the Department or for someone for whose action the Department is responsible, the selected agency may immediately give notice thereof in writing to the Competent Authority in the same manner as prescribed under sub Clause 5.2 seeking extension of time or rescheduling of milestone/s. The authority as indicated in Memorandum shall, if justified, give a fair and reasonable extension of time and reschedule the mile stones for completion of work after due consideration of the same within 30 days of receipt of such request. In event of non application by the selected agency for extension of time Competent Authority after affording opportunity to the selected agency may give, supported with a programme, a fair and reasonable extension within a reasonable period of occurrence of the event.

Such extension of time or rescheduling of milestone/s shall be without prejudice to any other right or remedy of the parties in contract or in law; provided further that for concurrent delays under this sub clause and sub clause 5.2 to the extent the delay is covered under sub clause 5.2 the selected agency shall be entitled to only extension of time and no damages.

5.4 Request for rescheduling of mile stones or extension of time, to be eligible for consideration, shall be made by the selected agency in writing within fourteen days of the happening of the event causing delay on the prescribed forms to be made available by Competent Authority.
The selected agency shall indicate in such a request the period by which rescheduling of milestone/s or extension of time is desired. With every request for rescheduling of milestones, or if at any time the actual progress of work falls behind the approved programme by more than 10% of the stipulated period of completion of contract, the selected agency shall produce a revised programme which shall include all details of pending drawings and decisions required to complete the contract and also the target dates by which these details should be available without causing any delay in execution of the work. A recovery as specified in memorandum shall be made on per day basis in case of delay in submission of the revised programme.

5.4.1 In any such case the authority as indicated in memorandum may give a fair and reasonable extension of time for completion of work or reschedule the mile stones. Such extension or rescheduling of the milestones shall be communicated to the selected agency by the authority as indicated in memorandum in writing, within 30 days of the date of receipt of such request from the selected agency in prescribed form. In event of non application by the selected agency for extension of time Competent Authority after affording opportunity to the selected agency may give, supported with a programme (as specified under 5.4 above), a fair and reasonable extension within a reasonable period of occurrence of the event.

5.5 In case the work is delayed by any reasons, in the opinion of the Competent Authority, by the selected agency for reasons beyond the events mentioned in clause 5.2 or clause 5.3 or clause 5.4 and beyond the justified extended date; without prejudice to right to take action under Clause 3, the Competent Authority may grant extension of time required for completion of work without rescheduling of milestones. The selected agency shall be liable for levy of compensation for delay for such extension of time.

6.0 Measurements of Work Done

Competent Authority shall, except as otherwise provided, ascertain and determine by measurement, the value in accordance with the contract of work done.

All measurement of all items having financial value shall be entered in Measurement Book (MB) and/or level field book so that a complete record is obtained of all works performed under the contract. All measurements and levels shall be taken jointly by the Competent Authority or his authorized representative and by the selected agency or

his authorized representative from time to time during the progress of the work and such measurements shall be signed and dated by the Competent Authority and the selected agency or their representatives in token of their acceptance. If the selected agency objects to any of the measurements recorded, a note shall be made to that effect with reason and signed by both the parties.

If for any reason the selected agency or his authorized representative is not available and the work of recording measurements is suspended by the Competent Authority, the Competent Authority and MoHUA shall not entertain any claim from selected agency for any loss or damages on this account. If the selected agency or his authorized representative does not remain present at the time of such measurements after the selected agency or his authorized representative has been given a notice in writing three (3) days in advance or fails to countersign or to record objection within a week from the date of the measurement, then such measurements recorded in his absence by the Competent Authority or his representative shall be deemed to be accepted by the selected agency. The selected agency shall, without extra charge, provide all assistance with every appliance, labour and other things necessary for measurements and recording levels. Except where any general or detailed description of the work expressly shows to the contrary, measurements shall be taken in accordance with the procedure set forth in the CPWD specifications notwithstanding any provision in the relevant standard method of measurement or any general or local custom. In the case of items which are not covered by CPWD specifications, measurements shall be taken in accordance with the relevant standard method of measurement issued by the Bureau of Indian Standards (BIS) and if for any item no such standard is available, then a mutually agreed method shall be followed.

The selected agency shall give, not less than seven days' notice to the Competent Authority or his authorized representative in charge of the work, before covering up or otherwise placing beyond the reach of measurement any work in order that the same may be measured and correct dimensions thereof be taken before the same is covered up or placed beyond the reach of measurement and shall not cover up and place beyond reach of measurement any work without consent in writing of the Competent Authority or his authorized representative in charge of the work who shall within the aforesaid period of seven days inspect the work, and if any work shall be covered up or placed beyond the reach of measurements without such notice having been given or the Competent Authority's consent being obtained in writing, the same shall be uncovered at the selected agency's expense, or in default thereof no payment or allowance shall be made for such work or the materials with which the same was executed. Competent Authority or his authorized representative may cause either themselves or through

another officer of the department to check the measurements recorded jointly or otherwise as aforesaid and all provisions stipulated herein above shall be applicable to such checking of measurements or levels.

It is also a term of this contract that recording of measurements of any item of work in the Measurement Book and/or its payment in the interim, on account or final bill shall not be considered as conclusive evidence as to the sufficiency of any work or material to which it relates nor shall it relieve the selected agency from liabilities from any over measurement or effects noticed till completion of the defects liability period.

6A Computerized Measurement Book

Competent Authority shall, except as otherwise provided, ascertain and determine by measurement the value of work done in accordance with the contract. All measurements of all items having financial value shall be entered by the selected agency and compiled in the shape of the Computerized Measurement Book having pages of A-4 size as per the format of the department so that a complete record is obtained of all the items of works performed under the contract. All such measurements and levels recorded by the selected agency or his authorized representative from time to time, during the progress of the work, shall be got checked by the selected agency from the Competent Authority or his authorized representative as per interval or program fixed in consultation with Competent Authority or his authorized representative. After the necessary corrections made by the Competent Authority, the measurement sheets shall be returned to the selected agency for incorporating the corrections and for resubmission to the Competent Authority for the dated signatures by the Competent Authority and the selected agency or their representatives in token of their acceptance.

Whenever bill is due for payment, the selected agency would initially submit draft computerized measurement sheets and these measurements would be got checked/test checked from the Competent Authority and/or his authorized representative. The selected agency will, thereafter, incorporate such changes as may be done during these checks/test checks in his draft computerized measurements, and submit to the department a computerized Measurement Book, duly bound, and with its pages machine numbered. The Competent Authority and/or his authorized representative would thereafter check this MB, and record the necessary certificates for their checks/test checks.

The final, fair, computerized measurement book given by the selected agency, duly bound, with its pages machine numbered, should be 100% correct, and no cutting or over-writing in the measurements would thereafter be allowed. If at all any error is noticed, the selected agency

shall have to submit a fresh Computerized MB with its pages duly machine numbered and bound, after getting the earlier MB cancelled by the department. The selected agency shall submit two spare copies of such Computerized MB's for the purpose of reference and record by the various officers of the department.

The selected agency shall also submit to the department separately his computerized Abstract of Cost and the bill based on these measurements, duly bound, and its pages machine numbered along with two spare copies of the "bill. Thereafter, this bill will be processed by the Division Office and allotted a number as per the computerized record in the same way as done for the Measurement Book meant for measurements.

The selected agency shall, without extra charge, provide all assistance with every appliance, labour and other things necessary for checking of measurements/levels by the Competent Authority or his representative.

Except where any general or detailed description of the work expressly shows to the contrary, measurements shall be taken in accordance with the procedure set forth in the specifications notwithstanding any provision in the relevant standard method of measurement or any general or local custom. In the case of items which are not covered by specifications, measurements shall be taken in accordance with the relevant standard method of measurement issued by the Bureau of Indian Standards (BIS) and if for any item no such standard is available then a mutually agreed method shall be followed.

The selected agency shall give not less than seven days' notice to the Competent Authority or his authorized representative in charge of the work before covering up or otherwise placing beyond the reach of checking and/or test checking the measurement of any work in order that the same may be checked and/or test checked and correct dimensions thereof be taken before the same is covered up or placed beyond the reach of checking and/or test checking measurement and shall not cover up and place beyond reach of measurement any work without consent in writing of the Competent Authority or his authorized representative in charge of the work who shall within the aforesaid period of seven days inspect the work, and if any work shall be covered up or placed beyond the reach of checking and/or test checking measurements without such notice having been given or the Competent Authority's consent being obtained in writing the same shall be uncovered at the selected agency's expense, or in default thereof no payment or allowance shall be made for such work or the materials with which the same was executed.

Competent Authority or his authorized representative may cause either themselves or through another officer of the department to check the measurements recorded by selected agency and all provisions stipulated

herein above shall be applicable to such checking of measurements or levels.

It is also a term of this contract that checking and/or test checking the measurements of any item of work in the Measurement Book and/or its payment in the interim, on account of final bill shall not be considered as conclusive evidence as to the sufficiency of any work or material to which it relates nor shall it relieve the selected agency from liabilities from any over measurement or defects noticed till completion of the defects liability period.

7.0 Payment on Intermediate Certificate to be regarded as advances

The interim or running account bills shall be submitted by the selected agency for the work executed on the basis of such recorded measurements on the format of the Department in triplicate on or before the date of every month fixed for the same by the Competent Authority. The selected agency shall not be entitled to be paid any such interim payment if the gross work done together with net payment/adjustment of advances for material collected, if any, since the last such payment is less than the amount specified in memorandum, in which case the interim bill shall be prepared on the appointed date of the month after the requisite progress is achieved. Competent Authority shall arrange to have the bill verified by taking or causing to be taken, where necessary, the requisite measurements of the work. In the event of the failure of the selected agency to submit the bills, no claims whatsoever due to delays on payment including that of interest shall be payable to the selected agency. Payment on account of amount admissible shall be made by the Competent Authority certifying the sum to which the selected agency is considered entitled by way of interim payment at such rates as decided by the Competent Authority. The amount admissible shall be paid by 15th working day after the day of presentation of the bill by the selected agency to the Competent Authority with the account of the material issued by the Department, or dismantled materials, if any. In case of delay in payment of intermediate bills after 45 days of submission of bill by the selected agency provided the bill submitted by the selected agency found to be in order, a simple interest @ 10% per annum shall be paid to the selected agency from the date of expiry of prescribed time limit which will be compounded on yearly basis.

All such interim payments shall be regarded as payment by way of advances against final payment only and shall not preclude the requiring of bad, unsound and imperfect or unskilled work to be rejected, removed, taken away and reconstructed or re-erected. Any certificate given by the Competent Authority relating to the work done or materials delivered forming part of such payment, may be modified or

corrected by any subsequent such certificate(s) or by the final certificate and shall not by itself be conclusive evidence that any work or materials to which it relates is/are in accordance with the contract and specifications. Any such interim payment, or any part thereof shall not in any respect conclude, determine or affect in any way powers of the Competent Authority under the contract or any of such payments be treated as final settlement and adjustment of accounts or in any way vary or affect the contract.

Pending consideration of extension of date of completion, interim payments shall continue to be made as herein provided without prejudice to the right of the department to take action under the terms of this contract for delay in the completion of work, if the extension of date of completion is not granted by the competent authority.

The Competent Authority in his sole discretion on the basis of a certificate from authorized officer by MoHUA to the effect that the work has been completed up to the level in question make interim advance payments without detailed measurements for work done (other than foundations, items to be covered under finishing items) up to lintel level (including sunshade etc.) and slab level, for each floor working out at 75% of the assessed value. The advance payments so allowed shall be adjusted in the subsequent interim bill to be submitted by the selected agency within 10 days of the interim payment. In case of delay in submission of bill by the selected agency a simple interest @ 10% per annum shall be paid to the Government from the date of expiry of prescribed time limit which will be compounded on yearly basis.

8.0 Completion Certificate and Completion Plans

Within ten days of the completion of the work, the selected agency shall give notice of such completion to the Competent Authority and within thirty days of the receipt of such notice, the Competent Authority shall inspect the work and if there is no defect in the work, shall furnish the selected agency with a final certificate of completion, otherwise a provisional certificate of physical completion indicating defects (a) To be rectified by the selected agency and/or (b) For which payment will be made at reduced rates, shall be issued. But no final certificate of completion shall be issued, nor shall the work be considered to be complete until the selected agency shall have removed from the premises on which the work shall be executed all scaffolding, surplus materials, rubbish and all huts and sanitary arrangements required for his/their work people on the site in connection with the execution of the works as shall have been erected or constructed by the selected agency(s) and cleaned off the dirt from all wood work, doors, windows, walls, floor or other parts of the building, in, upon, or about which the work is to be executed or of which he may have had possession for the purpose of the execution; thereof, and not until the work shall have

been measured by the Competent Authority. If the selected agency shall fail to comply with the requirements of this Clause as to removal of scaffolding, surplus materials and rubbish and all huts and sanitary arrangements as aforesaid and cleaning off dirt on or before the date fixed for the completion of work, the Competent Authority may at the expense of the selected agency remove such scaffolding, surplus materials and rubbish etc., and dispose of the same as he thinks fit and clean off such dirt as aforesaid, and the selected agency shall have no claim in respect of scaffolding or surplus materials as aforesaid except for any sum actually realized by the sale thereof.

8A Completion Plans to be submitted by the selected agency

The selected agency shall submit completion plan as required vide CPWD General Specifications for Electrical works (Part-I internal) 2013 and (Part-ll External) 1994 as amended up to date as applicable within thirty days of the completion of the work.

In case, the selected agency fails to submit the completion plan as aforesaid, he shall be liable to pay a sum of 0.1 % of Bided Value. The selected agency shall submit completion plan for Internal and External Civil, Electrical and Mechanical services within thirty days of the completion of the work, provided that the service plans having been issued for execution by the Competent Authority, unless the selected agency, by virtue of any other provision in the contract, is required to prepare such plans.

9.0 Payment of Final Bill

The final bill shall be submitted by the selected agency in the same manner as specified in interim bills within three months of physical completion of the work or within one month of the date of the final certificate of completion furnished by the Competent Authority whichever is earlier. No further claims shall be made by the selected agency after submission of the final bill and these shall be deemed to have been waived and extinguished. Payments of those items of the bill in respect of which there is no dispute and of items in dispute, for quantities and rates as approved by Competent Authority, will, as far as possible be made within six months, the period being reckoned from the date of receipt of the bill by the Competent Authority, complete with account of materials issued by the Department and dismantled materials.

9A Payment of Selected agency's Bills to Banks

Payments payable to selected agency may, if so desired by him, be made to agency's bank account.

10. Materials to be provided by the selected agency

The selected agency shall, at his own expense, provide all materials, required for the works other than those which are stipulated to be supplied by the Government.

The selected agency shall, at his own expense and without delay, supply to the Competent Authority samples of materials to be used on the work and shall get these approved in advance. All such materials to be provided by the selected agency shall be in conformity with the technical specifications as referred in the contract or CPWD specifications wherever applicable. The selected agency shall, if requested by the Competent Authority furnish proof, to the satisfaction of the Competent Authority that the materials so comply. The Competent Authority shall within thirty days of supply of samples or within such further period as he may require intimate to the selected agency in writing whether samples are approved by him or not. If samples are not approved, the selected agency shall forthwith arrange to supply to the Competent Authority for his approval, fresh samples complying with the specifications laid down in the contract. When materials are required to be tested in accordance with specifications, approval of the Competent Authority shall be issued after the test results are received.

The selected agency shall at his risk and cost submit the samples of materials to be tested or analyzed and shall not make use of or incorporate in the work any materials represented by the samples until the required tests or analysis have been made and materials finally accepted by the Competent Authority. The selected agency shall not be eligible for any claim or compensation either arising out of any delay in the work or due to any corrective measures required to be taken on account of and as a result of testing of materials.

The selected agency shall, at his risk and cost, make all arrangements and shall provide all facilities as the Competent Authority may require for collecting, and preparing the required number of samples for such tests at such time and to such place or places as may be directed by the Competent Authority and bear all charges and cost of testing unless specifically provided for otherwise elsewhere in the contract or specifications. The Competent Authority or his authorized representative shall at all times have access to the works and to all workshops and places where work is being prepared or from where materials, manufactured articles or machinery are being obtained for the works and the selected agency shall afford every facility and every assistance in obtaining the right to such access.

The Competent Authority shall have full powers to require the removal from the premises of all materials which in his opinion are not in accordance with the specifications and in case of default, the Competent Authority shall be at liberty to employ at the expense of the

selected agency, other persons to remove the same without being answerable or accountable for any loss or damage that may happen or arise to such materials. The Competent Authority shall also have full powers to require other proper materials to be substituted thereof and in case of default, the Competent Authority may cause the same to be supplied and all costs which may attend such removal and substitution shall be borne by the selected agency.

The selected agency shall at his own expense, provide a material testing lab at the site for conducting routine field tests. The lab shall be equipped at least with the testing equipment as specified in ANNEXURE-VI.

11.0Work to be executed in Accordance with Specifications, Drawings and Orders etc.

The selected agency shall execute the whole and every part of the work in the most substantial and workmanlike manner both as regards materials and otherwise in every respect in strict accordance with the specifications. The selected agency shall also conform exactly, fully and faithfully to the design, drawings and instructions in writing in respect of the work signed by the Competent Authority and the selected agency shall be furnished free of charge one copy of the contract documents together with specifications, designs, drawings and instructions as are not included in the standard specifications of Central Public Works Department specified in memorandum or in any Bureau of Indian Standard (BIS) or any other, published standard or code or,

Schedule of Rates (SoR) or any other printed publication referred to elsewhere in the contract. The selected agency shall comply with the provisions of the contract and with the care and diligence execute and maintain the works and provide all labour and materials, tools and plants including for measurements and supervision of all works, structural plans and other things of temporary or permanent nature required for such execution and maintenance in so far as the necessity for providing these, is specified or is reasonably inferred from the contract. The selected agency shall take full responsibility for adequacy, suitability and safety of all the works and methods of construction.

12.0Deviations/ Variations Extent and Pricing

The MoHUA reserves the Right to:

(i) make alteration in, omissions from, additions to, for the original specifications, drawings, designs and instructions that may appear to him to be necessary or advisable during the progress of the work, and

(ii) omit a part of the works in case of non-availability of a portion of the site or for any other reasons and the selected agency shall be bound to carry out the works in accordance with any instructions given to him in writing signed by the Competent Authority and

such alterations, omissions, additions or substitutions shall form part of the contract as if originally provided therein and any altered, additional or substituted work which the selected agency may be directed to do in the manner specified above as part of the works, shall be carried out by the selected agency on the same conditions in all respects including price on which he agreed to do the main work except as hereafter provided.

12.1 Extra Items& Substituted Item and Pricing

No extra Item will be entertained

13.0Foreclosure of contract due to Abandonment or Reduction in Scope of Work

If at any time after acceptance of the bid or during the progress of work, the purpose or object for which the work is being done changes due to any supervening cause and as a result of which the work has to be abandoned or reduced in scope the Competent Authority shall give notice in writing to that effect to the selected agency stating the decision as well as the cause for such decision and the selected agency shall act accordingly in the matter. The selected agency shall have no claim to any payment of compensation or otherwise whatsoever, on account of any profit or advantage which he might have derived from the execution of the works in full but which he did not derive in consequence of the foreclosure of the whole or part of the works.

(i) The selected agency shall be paid at contract rates, full amount for works executed at site and, in addition, a reasonable amount as certified by the Competent Authority for the items hereunder mentioned which could not be utilized on the work to the full extent in view of the foreclosure, any expenditure incurred on preliminary site work, e.g. temporary access roads, temporary labour huts, staff quarters and site office, storage accommodation and water storage tanks.

(ii) Government shall have the option to take over selected agency's materials or any part thereof either brought to site or of which the selected agency is legally bound to accept delivery from suppliers (for incorporation in or incidental to the work) provided, however Government shall be bound to take over the materials or such portions thereof as the selected agency does not desire to retain. For materials taken over or to be taken over by Government, cost of such materials as detailed by Competent Authority shall be paid. The cost shall, however, take into account purchase price, cost of transportation and deterioration or damage which may have been caused to materials whilst in the custody of the selected agency.

(iii) If any materials supplied by Government are rendered surplus, the same except normal wastage shall be returned by the selected agency to Government at rates not exceeding those at which these

were originally issued, less allowance for any deterioration or damage which may have been caused whilst the materials were in the custody of the selected agency.

In addition, cost of transporting such materials from site to Government stores, if so required by Government, shall be paid.

(iv) Reasonable compensation for transfer of T&P from site to selected agency's permanent stores or to his other works, whichever is less. If T&P are not transported to either of the said places, no cost of transportation shall be payable.

(v) Reasonable compensation for repatriation of selected agency's site staff and imported labour to the extent necessary.

(vi) The selected agency shall, if required by the Competent Authority, furnish to him, books of account, wage books, time sheets and other relevant documents and evidence as may be necessary to enable him to certify the reasonable amount payable under this condition.

The reasonable amount of items on (i), (iv) and (v) above shall not be in excess of 2% of the cost of the work remaining incomplete on the date of closure, i.e. total stipulated cost of the work as per accepted bid less the cost of work actually executed under the contract and less the cost of selected agency's materials at site taken over by the Government as per item (ii) above. Provided always that against any payments due to the selected agency on this account or otherwise, the Competent Authority shall be entitled to recover or be credited with any outstanding balances due from the selected agency for advance paid in respect of any tool, plants and materials and any other sums which at the date of termination were recoverable by the Government from the selected agency under the terms of the contract.

In the event of action being taken under Clause 13 to reduce the scope of work, the selected agency may furnish fresh Performance Bank Guarantee on the same conditions, in the same manner and at the same rate for the balance bided amount and initially valid up to the extended date of completion or stipulated date of completion if no extension has been granted plus 60 days beyond that. Wherever such a fresh Performance Bank Guarantee is furnished by the selected agency the Competent Authority may return the previous Performance Bank Guarantee.

14.0 Carrying out part work at risk & cost of selected agency

If selected agency:

(i) At any time makes default during currency of work or does not execute any part of the work with due diligence and continues to do so even after a notice in writing of 7 days in this respect from the Competent Authority; or

(ii) Commits default in complying with any of the terms and conditions of the contract and does not remedy it or takes effective steps to

remedy it within 7 days even after a notice in writing is given in that behalf by the Competent Authority, or

Fails to complete the work(s) or items of work with individual dates of completion, on or before the date(s) so determined, and does not complete them within the period specified in the notice given in writing in that behalf by the Competent Authority.

The Competent Authority without invoking action under clause 3 may, without prejudice to any other right or remedy against the selected agency which have either accrued or accrue thereafter to Government, by a notice in writing to take the part work/part incomplete work of any item(s) out of his hands and shall have powers to:

(a) Take possession of the site and any materials, constructional plant, implements, stores, etc., thereon; and/or

(b) Carry out the part work/part incomplete work of any item(s) by any means at the risk and cost of the selected agency.

The Competent Authority shall determine the amount, if any, is recoverable from the selected agency for completion of the part work/ part incomplete work of any item(s) taken out of his hands and execute at the risk and cost of the selected agency, the liability of selected agency on account of loss or damage suffered by Government because of action under this clause shall not exceed 10% of the bided value of the work.

In determining the amount, credit shall be given to the selected agency with the value of work done in all respect in the same manner and at the same rate as if it had been carried out by the original selected agency under the terms of his contract, the value of selected agency's materials taken over and incorporated in the work and use of plant and machinery belonging to the selected agency.

The certificate of the Competent Authority as to the value of work done shall be final and conclusive against the selected agency provided always that action under this clause shall only be taken after giving notice in writing to the selected agency. Provided also that if the expenses incurred by the department are less than the amount payable to the selected agency at his agreement rates, the difference shall not be payable to the selected agency.

Any excess expenditure incurred or to be incurred by Government in completing the part work/part incomplete work of any item(s) or the excess loss of damages suffered or may be suffered by Government as aforesaid after allowing such credit shall without prejudice to any other right or remedy available to Government in law or per as agreement be recovered from any money due to the selected agency on any account, and if such money is insufficient, the selected agency shall be called upon in writing and shall be liable to pay the same within 30 days.

If the selected agency fails to pay the required sum within the aforesaid period of 30 days, the Competent Authority shall have the right to sell any or all of the selected agency's unused materials, constructional plant, implements, temporary building at site etc. and adjust the proceeds of sale thereof towards the dues recoverable from the selected agency under the contract and if thereafter there remains any balance outstanding, it shall be recovered in accordance with the provisions of the contract.

In the event of above course being adopted by the Competent Authority, the selected agency shall have no claim to compensation for any loss sustained by him by reason of his having purchased or procured any materials or entered into any engagements or made any advance on any account or with a view to the execution of the work or the performance of the contract.

15.0Suspension of Work

(i) The selected agency shall, on receipt of the order in writing of the Competent Authority, (whose decision shall be final and binding on the selected agency) suspend the progress of the works or any part thereof for such time and in such manner as the Competent Authority may consider necessary so as not to cause any damage or injury to the work already done or endanger the safety thereof for any of the following reasons:

a) On account of any default on the part of the selected agency or;
b) For proper execution of the works or part thereof for reasons other than the default of the selected agency; or
c) For safety of the works or part thereof.

The selected agency shall, during such suspension, properly protect and secure the works to the extent necessary and carry out the instructions given in that behalf by the Competent Authority.

(ii) If the suspension is ordered for reasons (b) and (c) in sub-para (i) above:

a) The selected agency shall be entitled to an extension of time equal to the period of every such suspension plus 25%, for completion of the item or group of items of work for which a separate period of completion is specified in the contract and of which the suspended work forms a part, and;
b) If the total period of all such suspensions in respect of an item or group of items or work for which a separate period of completion is specified in the contract exceeds thirty days, the selected agency shall, in addition, be entitled to such compensation as the Competent Authority may consider reasonable in respect of salaries and/or wages paid by the selected agency to his employees and labour at site, remaining idle during the period of

suspension, adding thereto 2% to cover indirect expenses of the selected agency provided the selected agency submits his claim supported by details to the Competent Authority within 15 days of the expiry of the period of 30 days.

(iii) If the works or part thereof is suspended on the orders of the Competent Authority for more than three months at a time, except when suspension is ordered for reason (a) in sub para (i) above, the selected agency may after receipt of such order serve a written notice on the Competent Authority requiring permission within fifteen days from receipt by the Competent Authority of the said notice, to proceed with the work or part thereof in regard to which progress has been suspended and if such permission is not granted within that time, the selected agency, if he intends to treat the suspension, where it affects only a part of the works as an omission of such part by Government or where it affects whole of the works, as an abandonment of the works by Government, shall within ten days of expiry of such period of 15 days give notice in writing of his intention to the Competent Authority. In the event of the selected agency treating the suspension as an abandonment of the contract by Government, he shall have no claim to payment of any compensation on account of any profit or advantage which he might have derived from the execution of the work in full but which he could not derive in consequence of the abandonment. He shall, however, be entitled to such compensation, as the Competent Authority may consider reasonable, in respect of salaries and/or wages paid by him to his employees and labour at site, remaining idle in consequence adding to the total thereof 2% to cover indirect expenses of the selected agency provided the selected agency submits his claim supported by details to the Competent Authority within 30 days of the expiry of the period of 3 months.

16.0Action in case Work not done as per Specifications

All works under or in course of execution or executed in pursuance of the contract, shall at all times be open and accessible to the inspection and supervision of the Competent Authority, his authorized subordinates in charge of the work and all the superior officers, officers responsible for Quality Assurance Unit or any organization engaged by the Competent Authority for Quality Assurance and the selected agency shall, at all times, during the usual working hours and at all other times at which reasonable notice of the visit of such officers has been given to the selected agency, either himself be present to receive orders and instructions or have a responsible agent duly accredited in writing, present for that purpose.

Orders given to the selected agency's agent shall be considered to have the same force as if they had been given to the selected agency himself.

If it shall appear to the Competent Authority or his authorized subordinates in charge of the work or to the In-charge of Quality Assurance or his subordinate officers or the officers of the organization engaged by the Department for Quality Assurance or his subordinate officers, that any work has been executed with unsound, imperfect, or unskillful workmanship, or with materials or articles provided by him for the execution of the work which are unsound or of a quality inferior to that contracted or otherwise not in accordance with the contract, the selected agency shall, on demand in writing which shall be made within twelve months (six months in the case of work costing Rs. 10 Lakh and below except road work) of the completion of the work from the Competent Authority specifying the work, materials or articles complained of notwithstanding that the same may have been passed, certified and paid for forthwith rectify, or remove and reconstruct the work so specified in whole or in part, as the case may require or as the case may be, remove the materials or articles so specified and provide other proper and suitable materials or articles at his own charge and cost. In the event of the failing to do so within a period specified by the Competent Authority in his demand aforesaid, then the selected agency shall be liable to pay compensation at the same rate as under clause 2 of the contract (for non-completion of the work in time) for this default.

In such case the Competent Authority may not accept the particular item of work. The Competent Authority may accept such work/s at reduced rates as considered reasonable during the preparation of on account bills or final bill if the item is so acceptable without detriment to the safety and utility of the item and the structure or he may reject the work outright without any payment and/or get it and other connected and incidental items rectified, or removed and re-executed at the risk and cost of the selected agency.

Decision of the Competent Authority to be conveyed in writing in respect of the same will be final and binding on the selected agency.

17.0 Selected agency Liable for Damages, defects during defect liability period

If the selected agency or his working people or servants shall break, deface, injure or destroy any part of building in which they may be working, or any building, road, road kerb, fence, enclosure, water pipe, cables, drains, electric or telephone post or wires, trees, grass or grassland, or cultivated ground contiguous to the premises on which the work or any part is being executed, or if any damage shall happen to the work while in progress, from any cause whatever or if any defect, shrinkage or other faults appear in the work within twelve months (six months in the case of work costing Rs. Ten lakh and below except road work) after a certificate final or otherwise of its completion shall have been given by the Competent Authority as aforesaid arising out of defect

or improper materials or workmanship the selected agency shall upon receipt of a notice in writing on that behalf make the same good at his own expense or in default the Competent Authority cause the same to be made good by other workmen and deduct the expense from any sums that may be due or at any time thereafter may become due to the selected agency, or from his security deposit or the proceeds of sale thereof or of a sufficient portion thereof. The Security Deposit of the selected agency shall be refunded after completion of defect liability period.

18.0 Selected agency to Supply Tools & Plants etc.

The selected agency shall provide at his own cost all materials (except such special materials, if any, as may in accordance with the contract be supplied from the Competent Authority's stores), machinery, tools & plants as specified in ANNEXURE-VIII in addition to this, appliances, implements, other plants, ladders, cordage, tackle, scaffolding and temporary works required for the proper execution of the work, whether original, altered or substituted and whether included in the specifications or other documents forming part of the contract or referred to in these conditions or not, or which may be necessary for the purpose of satisfying or complying with the requirements of the Competent Authority as to any matter as to which under these conditions he is entitled to be satisfied, or which he is entitled to require together with carriage therefore to and from the work. The selected agency shall also supply without charge the requisite number of persons with the means and materials, necessary for the purpose of setting out works, and counting, weighing and assisting the measurement for examination at any time and from time to time of the work or materials. Failing his so doing, the same may be provided by the Competent Authority at the expense of the selected agency and the expenses may be deducted, from any money due to the selected agency, under this contract or otherwise and/or from his security deposit or the proceeds of sale thereof, or of a sufficient portions thereof.

18A Recovery of Compensation paid to Workmen

In every case in which by virtue of the provisions sub-section (1) of Section 12, of the Workmen's Compensation Act, 1923, Government is obliged to pay compensation to a workman employed by the selected agency, in execution of the works, Government will recover from the selected agency, the amount of the compensation so paid; and, without prejudice to the rights of the Government under sub-section (2) of Section 12, of the said Act, Government shall be at liberty to recover such amount or any part thereof by deducting it from the security deposit or from any sum due by Government to the selected agency whether under this contract or otherwise. Government shall not be bound to contest any claim made against it under sub-section (1) of

Section 12, of the said Act, except on the written request of the selected agency and upon his giving to Government full security for all costs for which Government might become liable in consequence of contesting such claim.

18B Ensuring Payment and Amenities to Workers if selected agency fails

In every case in which by virtue of the provisions of the Contract Labour (Regulation and Abolition) Act, 1970, and of the Contract Labour (Regulation and Abolition) Central Rules, 1971, Government is obliged to pay any amounts of wages to a workman employed by the selected agency in execution of the works, or to incur any expenditure in providing welfare and health amenities required to be provided under the above said Act and the rules under Clause 19H or under the C.P.W.D. selected agency's Labour Regulations, or under the Rules framed by Government from time to time for the protection of health and sanitary arrangements for workers employed by C.P.W.D. selected agency, Government will recover from the selected agency, the amount of wages so paid or the amount of expenditure so incurred; and without prejudice to the rights of the Government under sub-section(2) of Section 20, and sub-section (4) of Section 21, of the contract labour (Regulation and Abolition) Act, 1970, Government shall be at liberty to recover such amount or any part thereof by deducting it from the Security Deposit or from any sum due by Government to the selected agency whether under this contract or otherwise Government shall not be bound to contest any claim made against it under sub-section (1) of Section 20, sub-section (4) of Section 21, of the said Act, except on the written request of the selected agency and upon his giving to the Government full security for all costs for which Government might become liable in contesting such claim.

19. Labour Laws to be complied by the selected agency

The selected agency shall obtain a valid license under the Contract Labour (R&A) Act, 1970, and the Contract Labour (Regulation and Abolition) Central Rules, 1971, before the commencement of the work, and continue to have a valid license until the completion of the work. **The selected agency shall also comply with provisions of the Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979.**

The selected agency shall also abide by the provisions of the Child Labour (Prohibition and Regulation) Act, 1986.

The selected agency shall also comply with the provisions of the building and other Construction Workers (Regulation of Employment & Conditions of Service) Act, 1996 and the building and other Construction Workers Welfare Cess Act, 1996.

Any failure to fulfill these requirements shall attract the penal provisions of this contract arising out of the resultant non-execution of the work. No labour below the age of fourteen years shall be employed on the work. The ESI and EPF contributions on the part of MoHUA in respect of this contract shall be paid by the agency which shall not be reimbursed. The agency shall keep and maintain records pertaining to engaging labour, wages paid and their perks in prescribed Performa as approved by Competent Authority.

20. Minimum Wages Act to be complied with

The selected agency shall comply with all the provisions of the Minimum Wages Act, 1948, and Contract Labour (Regulation and Abolition) Act, 1970, amended from time to time and rules framed there under and other labour laws affecting contract labour that may be brought into force from time to time.

21. Work not to be sublet. Action in case of insolvency

The contract shall not be assigned or sublet without the written approval of the Competent Authority. And if the selected agency shall assign or sublet his contract, or attempt to do so, or become insolvent or commence any insolvency proceedings or make any composition with his creditors or attempt to do so, or if any bribe, gratuity, gift, loan, perquisite, reward or advantage pecuniary or otherwise, shall either directly or indirectly, be given, promised or offered by the participating agency, or any of his servants or agent to any public officer or person in the employ of Government in any way relating to his office or employment, or if any such officer or person shall become in any way directly or indirectly interested in the contract, the Competent Authority on behalf of the President of India shall have power to adopt the course specified in Clause 3 hereof in the interest of Government and in the event of such course being adopted, the consequences specified in the said Clause 3 shall ensue.

22. Compensation

All sums payable by way of compensation under any of these conditions shall be considered as reasonable compensation to be applied to the use of Government without reference to the actual loss or damage sustained and whether or not any damage shall have been sustained.

23. Changes in firm's Constitution to be intimated

Where the selected agency is a partnership firm, the previous approval in writing of the Competent Authority shall be obtained before any change is made in the constitution of the firm. Where the selected agency is an individual or a Hindu undivided family business concern, such approval as aforesaid shall likewise be obtained before the selected agency enters into any partnership agreement where under the

partnership firm would have the right to carry out the works hereby undertaken by the selected agency. If previous approval as aforesaid is not obtained, the contract shall be deemed to have been assigned in contravention of Clause 21 hereof and the same action may be taken, and the same consequences shall ensue as provided in the said Clause 21.

24. All works to be executed under the contract shall be executed under the direction and subject to the approval in all respects of the Competent Authority who shall be entitled to direct at what point or points and in what manner they are to be commenced, and from time to time carried on.

25. Settlement of Disputes & Arbitration

Except where otherwise provided in the contract, all disputes and claims relating to the meaning of the specifications, designs, drawings and instructions here-in-before mentioned and as to the quality of workmanship or materials used in the work or as to any other question, claim, right, matter or thing whatsoever in any way arising out of or relating to the contract, designs, drawings, specifications, estimates, instructions, orders or these conditions or otherwise concerning the work or the execution or failure to execute the same whether arising during the progress of the work or after the cancellation, termination, completion or abandonment thereof shall be dealt with as mentioned here-in-after.

If the agency considers any work demanded of him to be outside the requirements of the contract, or disputes any drawings, record or decision given in writing by the Competent Authority on any matter in connection with or arising out of the contract or carrying out of the work to be unacceptable, he shall promptly within 15 days request MoHUA or their designee/representative in writing for written instructions or decision. Thereupon, he shall give his written instructions or decision within a period of one month from the receipt of the agency's letter. If he fails to give his decision within the aforesaid period, or if any party is dissatisfied with the decision of MoHUA, then either party may within a period of 30 days from the receipt of the decision of MoHUA or from the last date prescribed above for the MoHUA to give his decision if he delays or fails to give his decision, give notice to MoHUA for appointment of an arbitral tribunal, failing which the said decision shall be final, binding and conclusive, and not referable to adjudication by arbitration. It is a term of contract that each party invoking arbitration must exhaust the aforesaid mechanism of settlement of disputes prior to invoking arbitration.

Except where the decision has become final, binding and conclusive in terms of sub-para (i) above, disputes shall be referred for adjudication through arbitration by an arbitral tribunal.

The arbitral tribunal shall consist of three arbitrators chosen from a panel of seven arbitrators prepared by MoHUA. The panel will comprise of engineers retired from any government service from a position not below the level of Joint Secretary to the Government of India and having experience in the field of arbitration in construction contracts.

The MoHUA shall within 30 days from the receipt of a request on prescribed proforma from either party for appointment of arbitral tribunal, shall appoint one arbitrator from the panel of seven arbitrators, while the second arbitrator shall be chosen by the agency. If agency fails to choose one arbitrator within ten days then the second arbitrator shall also be appointed by MoHUA. The two appointed arbitrators shall appoint the third arbitrator from the same panel, who shall act as the presiding arbitrator.

It is a term of this contract that the party invoking arbitration shall give a list of disputes with amounts claimed in respect of each such dispute along with the notice for appointment of arbitrator and giving reference to the rejection by the MoHUA.

The arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act, 1996 (26 of 1996) or any statutory modifications or re-enactment thereof and the rules made there under and for the time being in force shall apply to the arbitration proceeding under this clause.

It is also a term of this contract that the arbitral tribunal shall adjudicate on only such disputes as are referred to it by the appointing authority and give separate award against each dispute and claim referred to it and, in all cases, where the total amount of the claims by any party exceeds Rs 1,00,000/- the arbitral tribunal shall give reasons for the award.

The fees of the arbitral tribunal and the manner of its payment shall be determined by the arbitral tribunal after taking into consideration the rates specified in the Fourth Schedule of the Arbitration and Conciliation Act, 1996 as amended by the Amendment Act, 2015 or as per guidelines issued by the competent authority or ruling of Delhi High Court /Supreme Court of India.

26. Participating agency to indemnify Govt. Against Patent Rights

The selected agency shall fully indemnify and keep indemnified the President of India against any action, claim or proceeding relating to infringement or use of any patent or design or any alleged patent or design rights and shall pay any royalties which may be payable in respect of any article or part thereof included in the contract. In the

event of any claims made under or action brought against Government in respect of any such matters as aforesaid, the selected agency shall be immediately notified thereof and the selected agency shall be at liberty, at his own expense, to settle any dispute or to conduct any litigation that may arise there from, provided that the selected agency shall not be liable to indemnify the President of India if the infringement of the patent or design or any alleged patent or design right is the direct result of an order passed by the Competent Authority in this behalf.

27. Action where no Specifications are specified

In the case of any class of work for which there is no such specifications as referred to in Clause 11, such work shall be carried out in accordance with the Bureau of Indian Standards Specifications. In case, there are no such specifications in Bureau of Indian Standards, the work shall be carried out as per manufacturers' specifications, if not available then as per local/District Specifications. In case there are no such specifications as required above, the work shall be carried out in all respects in accordance with the instructions and requirements of the Competent Authority.

28. Withholding and lien in respect of sum due from selected agency

(i) Whenever any claim or claims for payment of a sum of money arises out of or under the contract or against the selected agency, the Competent Authority or the Government shall be entitled to withhold and also have a lien to retain such sum or sums in whole or in part from the security, if any deposited by the selected agency and for the purpose aforesaid, the Competent Authority or the Government shall be entitled to withhold the security deposit, if any, furnished as the case may be and also have a lien over the same pending finalization or adjudication of any such claim. In the event of the security being insufficient to cover the claimed amount or amounts or if no security has been taken from the selected agency, the Competent Authority or the Government shall be entitled to withhold and have a lien to retain to the extent of such claimed amount or amounts referred to above, from any sum or sums found payable or which may at any time thereafter become payable to the selected agency under the same contract or any other contract with the Competent Authority of the Government or any contracting person through the Competent Authority pending finalization of adjudication of any such claim. It is an agreed term of the contract that the sum of money or moneys so withheld or retained under the lien referred to above by the Competent Authority or Government will be kept withheld or retained as such by the Competent Authority or Government till the claim arising out of or under the contract is determined by the arbitrator(if the contract is governed by the arbitration clause) by the competent court, as the case may be and that the selected agency

will have no claim for interest or damages whatsoever on any account in respect of such withholding or retention under the lien referred to above and duly notified as such to the selected agency. For the purpose of this clause, where the selected agency is a partnership firm or a limited company, the Competent Authority or the Government shall be entitled to withhold and also have a lien to retain towards such claimed amount or amounts in whole or in part from any sum found payable to any partner/limited company as the case may be, whether in his individual capacity or otherwise.

(ii) Government shall have the right to cause an audit and technical examination of the works and the final bills of the selected agency including all supporting vouchers, abstract, etc., to be made after payment of the final bill and if as a result of such audit and technical examination any sum is found to have been overpaid in respect of any work done by the selected agency under the contract or any work claimed to have been done by him under the contract and found not to have been executed, the selected agency shall be liable to refund the amount of over-payment and it shall be lawful for Government to recover the same from him in the manner prescribed in sub-clause (i) of this clause or in any other manner legally permissible; and if it is found that the selected agency was paid less than what was due to him under the contract in respect of any work executed by him under it, the amount of such under payment shall be duly paid by Government to the selected agency, without any interest thereon whatsoever.

Provided that the Government shall not be entitled to recover any sum overpaid, nor the selected agency shall be entitled to payment of any sum paid short where such payment has been agreed upon between the authorized officer from MoHUA on the one hand and the selected agency on the other under any term of the contract permitting payment for work after assessment by the authorized officer from MoHUA.

29. Lien in respect of claims in other Contracts

Any sum of money due and payable to the selected agency (including the security deposit returnable to him) under the contract may be withheld or retained by way of lien by the Competent Authority or the Government or any other contracting person or persons through Competent Authority against any claim of the Competent Authority or Government or such other person or persons in respect of payment of a sum of money arising out of or under any other contract made by the selected agency with the Competent Authority or the Government or with such other person or persons.

It is an agreed term of the contract that the sum of money so withheld or retained under this clause by the Competent Authority or the Government will be kept withheld or retained as such by the Competent

Authority or the Government or till his claim arising out of the same contract or any other contract is either mutually settled or determined by the arbitration clause or by the competent court, as the case may be and that the selected agency shall have no claim for interest or damages whatsoever on this account or on any other ground in respect of any sum of money withheld or retained under this clause and duly notified as such to the selected agency.

30. Arrangement of water for construction

The selected agency(s) shall make his/their own arrangements for water required for the work and nothing extra will be paid for the same. This will be subject to the following conditions. That the water used by the selected agency(s) shall be fit for construction purposes to the satisfaction of the Competent Authority.

31. Employment of Technical Staff and employees as per Annexure-VIII

Selected agency Superintendence, Supervision, Technical Staff & Employees (i) The selected agency shall provide all necessary superintendence during execution of the work and all along thereafter as may be necessary for proper fulfilling of the obligations under the contract.

The selected agency shall immediately after receiving letter of acceptance of the bid and before commencement of the work, intimate in writing to the Competent Authority, the name(s), qualifications, experience, age, address(s) and other particulars along with certificates, of the principal technical representative to be in charge of the work and other technical representative(s) who will be supervising the work. Minimum requirement of such technical representative(s) and their qualifications and experience shall not be lower than specified in this document. The Competent Authority shall within 3 days of receipt of such communication, intimate in writing his approval or otherwise of such a representative(s) to the selected agency. Any such approval may at any time be withdrawn and in case of such withdrawal, the selected agency shall appoint another such representative(s) according to the provisions of this clause. Decision of the bid accepting authority shall be final and binding on the selected agency in this respect. Such a principal technical representative and other technical representative(s) shall be appointed by the selected agency soon after receipt of the approval from Competent Authority and shall be available at site before start of work.

All the provisions applicable to the principal technical representative under the Clause will also be applicable to other technical representative(s). The principal technical representative and other technical representative(s) shall be present at the site of work for supervision at all times when any construction activity is in progress

and also present himself/themselves, as required, to the Competent Authorityand/or his designated representative to take instructions. Instructions given to the principal technical representative or other technical representative(s) shall be deemed to have the same force as if these have been given to the selected agency. The principal technical representative and other technical representative(s) shall be actually available at site fully during all stages of execution of work, during recording/checking/test checking of measurements of works and whenever so required by the Competent Authority and shall also note down instructions conveyed by the Competent Authority or his designated representative(s) in the site order book and shall affix his/their signature in token of noting down the instructions and in token of acceptance of measurements/checked measurements/test checked measurements. The representative(s) shall not look after any other work. Substitutes, duly approved by Competent Authority of the work, in similar manner as aforesaid shall be provided in event of absence of any of the representative(s) by more than two days.

If the Competent Authority, whose decision in this respect is final and binding on the selected agency, is convinced that no such technical representative(s) is/are effectively appointed or is/are effectively attending or fulfilling the provision of this clause, a recovery (nonrefundable) shall be effected from the selected agency as specified in Memorandum in this document and the decision of the Competent Authorityas recorded in the site order book and measurement recorded checked/test checked in Measurement Books shall be final and binding on the selected agency. Further if the selected agency fails to appoint suitable technical Principal technical representative and/or other technical representative(s) and if such appointed persons are not effectively present or are absent by more than two days without duly approved substitute or do not discharge their responsibilities satisfactorily, the Competent Authority shall have full powers to suspend the execution of the work until such date as suitable other technical representative(s) is/are appointed and the selected agency shall be held responsible for the delay so caused to the work. The selected agency shall submit a certificate of employment of the technical representative(s) (in the form of copy of Form-16 or CPF deduction issued to the Engineers employed by him) along with every on account bill final bill and shall produce evidence if at any time so required by the Competent Authority.

The selected agency shall provide and employ on the site only such technical assistants as are skilled and experienced in their respective fields and such foremen and supervisory staff as are competent to give proper supervision to the work. The selected agency shall provide and employ skilled, semiskilled and unskilled labour as is necessary for proper and timely execution of the work. The Competent Authority shall

be at liberty to object to and require the selected agency to remove from the works any person who in his opinion misconducts himself, or is incompetent or negligent in the performance of his duties or whose employment is otherwise considered by the Competent Authorityto be undesirable. Such person shall not be employed again at works site without the written permission of the Competent Authorityand the persons so removed shall be replaced as soon as possible by competent substitutes.

32. Levy/Taxes payable by selected agency

(i) GST, Building and other Construction Workers Welfare Cess or any other tax, levy or Cess in respect of input for or output by this contract shall be payable by the selected agency and Government shall not entertain any claim whatsoever in this respect except as provided under Clause 38.

(ii) The selected agency shall deposit royalty and obtain necessary permit for supply of the red bajri, stone, kankar, etc. from local authorities.

If pursuant to or under any law, notification or order any royalty, cess or the like becomes payable by the Government of India and does not any time become payable by the selected agency to the State Government, local authorities in respect of any material used by the selected agency in the works, then in such a case, it shall be lawful to the Government of India and it will have the right and be entitled to recover the amount paid in the circumstances as aforesaid from dues of the selected agency.

33. Conditions for reimbursement of levy/taxes if levied after receipt of bids

(i) All bided rates shall be inclusive any tax, levy or cess applicable on last stipulated date of receipt of bid including extension if any. No adjustment i.e. increases or decrease shall be made for any variation in the rate of GST, Building and Other Construction Workers Welfare Cess or any tax, levy or cess applicable on inputs. However, effect of variation in rates of GST or Building and Other Construction Workers Welfare Cess or imposition or repeal of any other tax, levy or cess applicable on output of the works contract shall be adjusted on either side, increase or decrease.

Provided further that for Building and Other Construction Workers Welfare Cess or any tax (other than GST), levy or cess varied or imposed after the last date of receipt of bid including extension if any, any increase shall be reimbursed to the selected agency only if the selected agency necessarily and properly pays such increased amount of taxes/levies/cess.

Provided further that such increase including GST shall not be made in the extended period of contract for which the selected agencyalone

is responsible for delay as determined by authority for extension of time under Clause 5.

(ii) The selected agency shall keep necessary books of accounts and other documents for the purpose of this condition as may be necessary and shall allow inspection of the same by a duly authorized representative of the Government and/or the Competent Authorityand shall also furnish such other information/document as the Competent Authoritymay require from time to time.

(iii) The selected agency shall, within a period of 30 days of the imposition of any such further tax or levy or cess, give a written notice thereof to the Competent Authoritythat the same is given pursuant to this condition, together with all necessary information relating thereto.

34. Termination of Contract on death of selected agency

Without prejudice to any of the rights or remedies under this contract, if the selected agency dies, the Competent Authorityon behalf of the President of India shall have the option of terminating the contract without compensation to the selected agency.

35. If relative working in MoHUA then the selected agency not allowed to bid

The selected agency shall not be permitted to bid for works in the MOHUA responsible for award and execution of contracts in which his near relative is posted as Divisional Accountant or as an officer in any capacity between the grades of the Superintending Engineer and Junior Engineer (both inclusive). He shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives to any Gazette Officer in MoHUA. Any breach of this condition by the selected agency would render him liable to be removed from the approved list of selected agency's of this Department. If however, the selected agency is registered in any other department; he shall be debarred from biding in MoHUA for any breach of this condition.

NOTE: By the term "near relatives" is meant wife, husband, parents and grandparents, children and grand children, brothers and sisters, uncles, aunts and cousins and their corresponding in-laws.

36. Compensation during war like situations

The work (whether fully constructed or not) and all materials, machines, tools and plants, scaffolding, temporary buildings and other things connected therewith shall be at the risk of the selected agency until the work has been delivered to the Competent Authority and a certificate from him to that effect obtained. In the event of the work or any materials properly brought to the site for incorporation in the work

being damaged or destroyed in consequence of hostilities or warlike operation, the selected agency shall when ordered (in writing) by the Competent Authorityto remove any debris from the site, collect and properly stack or remove in store all serviceable materials salvaged from the damaged work and shall be paid at the contract rates in accordance with the provision of this agreement for the work of clearing the site of debris, stacking or removal of serviceable material and for reconstruction of all works ordered by the Competent Authority, such payments being in addition to compensation upto the value of the work originally executed before being damaged or destroyed and not paid for. In case of works damaged or destroyed, but not already measured and paid for, the compensation shall be assessed by the Divisional Officer uptoRs.5,000/- and by the Superintending Engineer concerned for a higher amount. The selected agency shall be paid for the damages/destruction suffered and for restoring the material at the rate based on analysis of rates bided for in accordance with the provision of the contract. The certificate of the Competent Authorityregarding the quality and quantity of materials and the purpose for which they were collected shall be final and binding on all parties to this contract.

Provided always that no compensation shall be payable for any loss in consequence of hostilities or warlike operations (a) unless the selected agency had taken all such precautions against air raid as are deemed necessary by the A.R.P. Officers or the Competent Authority(b) for any material etc. not on the site of the work or for any tools, plant, machinery, scaffolding, temporary building and other things not intended for the work.

In the event of the selected agency having to carry out reconstruction as aforesaid, he shall be allowed such extension of time for its completion as is considered reasonable by the Authorized Officer.

37. Apprentices Act provisions to be complied with

The selected agency shall comply with the provisions of the Apprentices Act, 1961 and the rules and orders issued there under from time to time. If he fails to do so, his failure will be a breach of the contract and the Authorized Officermay, in his discretion, cancel the contract. The selected agency shall also be liable for any pecuniary liability arising on account of any violation by him of the provisions of the said Act.

38. Release of Security deposit after labour clearance

Release of Security Deposit of the work shall not be refunded till the selected agency produces a clearance certificate from the Labour Officer. As soon as the work is virtually complete, the selected agency shall apply for the clearance certificate to the Labour Officer under intimation to the Competent Authority. The Competent Authority, on

receipt of the said communication, shall write to the Labour Officer to intimate if any complaint is pending against the selected agency in respect of the work. If no complaint is pending, on record till after 3 months after completion of the work and/or no communication is received from the Labour Officer to this effect till six months after the date of completion, it will be deemed to have received the clearance certificate and the Security Deposit will be released if otherwise due.

ANNEXURE-IV

MEMORANDUM

Sl. No.	Description	Values/Description to be Applicable for Relevant Clause(s) as per Site
1)	Name of Work	**Construction of ..... EWS units at LHP site at ..... including all associated facilities and services, development works complete as per scope of work, drawings, etc.**
2)	Client/Owner	Ministry of Housing and Urban Affairs, Govt. of India
3)	Type of Bid	EPC
4)	Earnest Money Deposit (for each package)	Rs 2.5 Crore (Rupees Two Crore Fifty Lakh only)
5)	Estimated Cost (of each package)	Rs 125.0 Crore (Rupees One Hundred Twenty Five Crore Only)
6)	Time allowed for Construction of Work (for each package)	12 Months (Twelve Months) from the date of handing over the site and approvals.
7)	Mobilization Advance	Nil
8)	Performance Guarantee	5.00 % (Five Percent Only) of contract value within 15 days from the issue of Letter of Award. Maximum allowable 30 days. After 15 days a late fee @ 0.1% per day of PG amount shall be payable which shall be non-refundable.
9)	Security Deposit / Retention Money	5.00% (Five Percent Only) of the gross value of each running/final bill.
10)	Time allowed for starting the work	The date of start of contract shall be reckoned from the date of handing over the site and approvals.
11)	Escalation	All rates as quoted by participating agency shall be firm and fixed for entire contract period as well as extended period for completion of the works. **No escalation shall be applicable on this contract.** Escalation cost towards any change in statutory taxes will be accepted.
12)	Defect Liability Period	**Five Years** after issuance of date of Completion Certificate by MoHUA.
13)	Standard Schedule of rates & specifications	The latest schedule of rates and specification issued by CPWD till the last date of submission of bid shall be followed wherever applicable.

14)	Authority for fixing compensation under Clause-2, Extension of time, Rescheduling of Milestones and Shifting of date of start in case of delay in handing over of site and deciding reduced rates	MoHUA through its authorized representative / agency.

15) Description of Milestone

S.No.	Description of Milestones D = Date of Award of work D1 = Date of commencement of work on ground (D + 3 months)	Time Allowed in Months	Amount to be withheld in case of non achievement of Milestone
1	Submission of Inception Report, detailed survey, Architectural drawings ready for submission for approval of local bodies	D+ 1.5 months	
2	On approval of local bodies, EIA clearances and other statutory approvals of local bodies, final Architectural drawing showing electrical and sanitary layout plan and drawings and its submission	D + 2 months	0.75%
3	On submission and approval of Vetted structural design by Competent Authority	D + 3 months	
4	Completion of excavation work, laying of foundation and reaching plinth level of all towers	D1 + 2 months	1.0 %
5	Completion of Civil works of super-structure of all towers	D1 + 8 months	2.0 %
6	Completion of residential units fit with all Civil, Electrical, Mechanical services	D1 + 10 months	0.75 %
7	All Civil, Electrical, Mechanical and Horticulture work completed in all respect in residential and non-residential buildings with services, clearance from local body/ completion certificate require to declare buildings and campus	D1 + 12 months	0.5 %

		authorized for occupation		
	Note: 1. In the event of non-achieving the necessary progress as assessed from the running payment, above amount will be withheld for failure of each milestone subject to Maximum 5%. 2. The milestones mentioned at S.No. 1, 2 3 are to be completed within three months from date of award of work, time allowed within S. No. 1, 2, 3.			
16)	Amount of work done for Running bills	Rs. 12 Crore		
17)	Technical representatives required to be engaged at site	As per ANNEXURE-VIII		

ANNEXURE-V

Performa for JVA

JOINT VENTURE AGREEMENT (ON NON-JUDICIAL STAMP PAPER OF APPROPRIATE VALUE)

JOINT VENTURE AGREEMENT BETWEEN M/S …… AND M/S …….. FOR SUCCESSFUL PERFORMANCE OF THE CONTRACT FOR ……(INSERT NAME OF CONTRACT, BRIEF
DESCRIPTION OF WORKS AND NAME OF CLIENT)

This Joint Venture Agreement executed on this …….. day of ……. two thousand and …….. between M/s…….. …… a Company incorporated under the law of …….. And having its Registered Office at ……. (Member-1 having more than 51% of share interest in the JV,

Herein after called the "Lead member" Which expression shall include its successors,administrators, executors and permitted assigns) and M/s …….. a Company incorporated under the law of …….. and having its Registered Office at…….. (hereinafter called the "Member-2" which expression shall include its successor, administrators Executors and permitted assigns) for the purpose of submitting a bid and entering into a Contract (in case of award) against Bid document No…….. invited by MoHUA…….
…….. AND

WHEREAS

the Bidding Documents stipulates that the selected agency for participation in the Selection Process may be a single entity or a Joint Venture (JV) of two entities. AND WHERAS the bid is being submitted to the MoHUA on behalf of the JV in accordance with the requirements of the Joint Venture criteria as stipulated in the Bid documents. NOW THEREFORE, THIS DEED WITNESSETH AS UNDER:

1. That All the responsibilities and obligations of each of the Members delineated in this agreement are expressly understood and agreed between the Members. The share of Lead Member shall be ……% and share of other Member shall be ……% in the Joint Venture.
2. That in consideration of the Award of Contract by MoHUA to the Member-1 on behalf of JV,

we the members to the Joint Venture Agreement do hereby agree that Member-1 shall act as lead member of the JV. The lead member is authorized to deal with the bid, make all correspondence with MoHUA and further to sign the agreement, enter into contract and similar such actions in respect of the bided work.

3. The lead member which shall represent the JV in all the dealings with MoHUA shall be solely and severally responsible for performance of the entire contract for and on behalf of any or both the members of the Joint Venture.
4. JVA shall be valid during the entire currency of the contract including the period ofextension, if any. Both the members of the JV shall remain associated with the project till completion of the project. There shall be significant technical contribution of both the members for the project. However, after completion of the project, lead member shall be solely responsible for all responsibilities and liabilities of JV.

5. Once the bid is submitted, the JVA shall not be modified/altered/terminated during the validity of the bid. In case any member of the JV fails to observe /comply with this stipulation, the full Earnest Money Deposit (EMD) shall be liable to be forfeited. Similarly, after the contract is awarded, the constitution of JV shall not be allowed to be altered during the currency of contract. Failure to observe this stipulation shall be deemed to be the breach of contract with all contractual consequences.

6. No member of the JV shall have the right to assign or transfer the interest right or liability in respect of contract without the written consent of the other member and that of MoHUA.

7. In case of any breach of this Contract committed by any of the Members of theJoint Venture Agreement, both the Members do hereby undertake, declare and

Confirm that both the members shall be solely and severally responsible for Performance of the works in accordance with the terms and conditions of the NIT, for the work of

_____

Bid Document and/or Contract and undertake to carry out all the obligations andresponsibilities under this Joint Venture Agreement.

8. If the owner sustains any loss or damage on account of any breach of the contract, the lead member of Joint Venture undertake to pay such loss/damages, caused to the MoHUA on its written demand without any demur, reservation, contest or protest in any manner whatsoever. This is without prejudice to any rights of the MoHUA against the Joint Venture/lead member under the contract and/or guarantees.

9. We agree that this Agreement shall be without any prejudice to the various liabilities of the Joint Venture Members including the performance security as well as other obligations of Joint Venture members in terms of the contract.

10. The Joint Venture members will be fully governed by the terms and conditions of the contract and shall be responsible for the quality of all the works and timely execution thereof to meet the completion schedule under the contract.

11. This Agreement shall be construed and interpreted in accordance with the Laws of India and the respective courts of India shall have exclusive jurisdiction to adjudicate upon the disputes between the parties.

12. We, the Joint Venture members agree that this Agreement shall be irrevocable and shall form an integral part of the Contract. We further agree that this agreement shall continue to be enforceable till the successful completion of contract and till the MoHUA discharges it.

13. On award of contract, a single Performance Bank Guarantee shall be submitted by the lead member on behalf of JV as per bid conditions.

14. This Agreement shall not be construed as establishing or giving effect to any legal entity such as, a company, a partnership, etc. It shall relate solely towards MoHUA/the MoHUA for submission of Bid/Bid and related

execution of works to be performed pursuant to the contract and shall not extend to any other activities.

15. That this Agreement shall be operative from the effective date of the contract.

IN WITNESS WHEREOF, the Joint Venture members through their authorized

Representatives have executed these presents and affixed common seal of their respective companies, on the day, month and year first mentioned above.

For M/s .....(Joint Venture- Lead Member)
Witness: 1. ....

For M/s .....(Joint Venture Member-2)
Witness: 1. .....

ANNEXURE-VI

ESTABLISHING SITE LABORATORY AND TESTING OF MATERIALS (as per Proposed Technology)

Equipments for conducting necessary tests shall be provided and installed at site in the well-furnished site laboratory by the agency at its own cost to establish that the work is being done as per contract specifications and standards. It is also suggested thatsite laboratory need to be kept at Standard Atmospheric Temperature and humidity.

A SUGGESTIVE LIST OF PLANT AND EQUIPMENT AT SITE

(As per Proposed Technology)- to be provided by the Selected agency

The plant and equipment as required for the technology are to be provided by selected agency here. The space for setting up such onsite facilities shall be provided by State/ ULB/ DA for production of components/ products as applicable.

ANNEXURE-VIII

Minimum Requirement of technical Representative at Site

Requirement of Technical Representative(s) and Recovery Rates

S. No		Requirement of Technical Staff		Minimum Experience (Years)	Designation of Technical Staff	Rate of recovery if provision of clause 36(i) not fulfilled
		Qualification	Strength			
1		Graduate Engineer	1 No	20 (and having experience of one similar nature of work)	Project Manager	Rs.1,25,000/- per Month
2	a	Graduate (Civil/ Billing) Engineer	1 No	12 (and having experience of one similar nature of work)	Deputy Project Manger	Rs. 80,000/- per Month
	b	Graduate (MEP) Engineer	1 No	-do-	Deputy Project Manger	Rs. 80,000/- per Month
3	a	Civil Graduate Engineer Or Diploma Engineer	2 No.s	5 to 10	Project / site Engineer	Rs. 50,000/- per Month per person
	b	Civil Graduate Engineer Or Diploma Engineer	1 No	5 to 10	Quality Control Engineer	Rs. 50,000/- per Month per person
	c	Electrical Graduate Engineer Or Diploma Engineer	1 No	5 to 10	Project / site Engineer	Rs. 50,000/- per Month per person
	d	Graduate Engineer/ MBA in Project Management	1No	5	Planning Engineer	Rs. 50,000/- per Month per person
4	a	Civil	4 Nos	5	Supervisors	Rs. 30,000/-

		Diploma Engineer				per Month per person
	b	Electrical Diploma Engineer	2 Nos	3	Supervisors	Rs. 30,000/- per Month per person
	c	Mechanical and Plumbing Engineer	2 No	5	Supervisors	Rs. 30,000/- per Month per person
	d	IT/ Communication/ MCA	1 No	5	IT Engineer	Rs. 50,000/- per Month per person

Note:

1. Assistant Engineers retired from Government services, who are holding Diploma will be treated at par with graduate Engineers. Diploma holder with minimum 10-years relevant experience with a reputed construction company can be treated at par with graduate Engineers for such deployment subject to the condition that such Diploma holders should not exceed 50% of requirement of degree engineers.
2. The above given strength shall be required to be deployed as and when necessity arises at site or so directed by Competent Authority.
3. The Selected agency shall submit a certificate of employment of the technical representative(s) along with every account bill/final bill and shall produce evidence of regular physical availability of such engineers on the above project if at any times so required by the Competent Authority.

SECTION-A

General Conditions of Work & Planning and Designing

1. Use of Alternate Technology

1.1. The agency shall use "Alternate Technology" which have been presented by them during Construction Technology India – 2019 (CTI-2019): Expo-cum-conference of Global Housing Technology Challenge-India and finally shortlisted by MoHUA for the region. The Technology proposed should have sufficient credentials and authentic performance certification for its soundness by Government Institutes/Organisations.

1.2. It will be the responsibility of the agency to establish that the proposed technology is worth adopting for this work and shall provide value addition in respect of quality and time.

1.3. The agency shall use the technology listed in Annexure-A for the region and number of storey. The agency shall provide detailed specifications and execution methodology to be adopted for the execution of the work. The agency shall support the proposal along with the details where this technology has been successfully used in the prescribed proforma given in this bid. The agency shall make their own sufficient arrangements for visit to the LHP site at own expense.

1.4. It shall be the responsibility of agency to establish the credibility of the technology being proposed by him. The agency shall be responsible for the performance of the technology used and buildings constructed by using this. If agency fails to complete the work with the proposed technology then agency shall be liable to complete the work by using other technology/s as suggested by Competent Authority. The cost incurred in doing so shall be borne by the agency completely.

1.5. The MoHUA through BMTPC shall engage an "Independent Agency" for third party quality assurance at their own cost.This independent agency shall be engaged after due approval of Competent Authority. This Independent Agency shall be a Government Institute /Organization/Central PSU.

1.6. The agency shall engage professionals with experience of proposed technology as per list mentioned in ANNEXURE-VIII.

1.7. All necessary measures like thermal comfort, fire-fighting provisions, natural light and ventilation, etc. shall be taken by the agency to provide as per NBC 2016 and as define in Scope of work earlier in the RFP document.

1.8. The necessary suggestions if any, given by the Competent Authorityfor carrying out the construction work with

alternatetechnology shall be incorporated by the agency for which nothing extra shall be payable.

1.9. The agency shall submit the list of laboratories equipments for test and locations of the same along with the proposal of technology. The decision of Competent Authorityshall be final in this matter.

1.10. The agency shall provide the list and numbers of T&P/ equipments etc. likely to be used for completing the work. The agency shall engage the same during the execution.

2.0 Scope of Work

2.1 The work shall be executed in accordance with the site-specific layout plan (same are enclosed in RFP), architectural, structural and services drawings on EPC basis from concept to completion and handing over in fit conditions ready for occupation.

2.2 The land is free from encroachment and all encumbrances and there is no hindrance to execute the work. The agency shall fix a permanent bench mark at the site of work. All necessary approvals will be provided by the State/ ULB/ DA on request of selected agency as committed during the LHP proposal by the State Govt. to MoHUA. Plinth level (where stilt is provided) shall be as per CPWD norms however, it should be above existing road level. The general ground level of the whole campus shall be as per CPWD norms above the adjoining external road level. In case of residential units are proposed on ground Level (due to any unavoidable reasons) the plinth level shall be as per CPWD normsabove the adjoining external road level. The data provided in this RFP are indicative and for general guidelines. Changes, if any, would not affect the agreed rates and no claim on this account shall be entertained.

2.3 Scope of the work shall include but not limited to the following:

2.3.1 To carry out survey of the site handed over for execution of the project and shall verify the site dimensions as per the site plan provided with RFP or made available by Competent Authority.

2.3.2 The agency shall have to prepare the architectural drawings, layout plan for the site accommodating specified numbers of houses and related infrastructure facilities as per prevailing local building bye-laws and development control norms in the area of concerned State. The agency shall prepare all drawings and layouts, get all statutory approvals from concerned authorities.

2.3.3 The agency should attempt sustainable habitat encompassing all environment friendly, energy efficient and barrier free design.

2.4 Detailed Soil investigation is to be conducted by the agency as per the relevant BIS code/NBC 2016 for determining type of foundation and its design from the consultant approved by Competent Authority.

2.5 Allowable safe bearing capacity for structural design shall be adopted after due approval of MoHUA.

2.6 To prepare complete structural design drawings for foundations, superstructure, services, and for other structures to be provided/constructed within works area, as per the provision contained in IS Codes/NBC2016, taking into consideration the protection against seismic/ wind forces required for disaster resistance structures. The structural drawings shall got approved from Competent Authority and to facilitate it, MoHUA may engage consultant for examination of design and advising Competent Authority. After approval of the structural drawings by Competent Authority, if any modification in design/drawing is needed, as per site conditions, the agency shall do/re-do without any extra cost. The decision of the Competent

Authority shall be final and binding. No claim whatsoever will be entertained on this account.

2.7 Planning, designing and execution of all internal services like internal sanitary, water supply, drainage system etc. complete for the buildings planned including all its fittings, fixtures, testing etc.

2.8 Planning, designing and execution of all external services like water supply, rain water harvesting systems, system for recycling of waste water, position of tube wells for horticulture, sewerage, drainage system, roads, paths and all connected sub-structures and superstructures within the premises, as per bye-laws and norms of the local bodies including making connections with the peripheral services after getting the services design approved from the local bodies.

2.9 Planning, designing and construction/installation of underground reservoirs, pump houses for water supply, for firefighting tank including installing of pumps, standby pumps as per approved drawings/specifications or as directed by Competent Authority.

2.10 Planning, designing & installation of waste water recycle system, including all equipments etc. shall be in the scope of the agency. The decision of Competent Authority shall be final.

2.11 Planning, designing and execution of the roof top rain water harvesting system for recharging the sub-soil water including laying of pipe lines and construction of substructure/superstructures. The designs, system shall be adhering to minimum norms define for intensity of rainfall in area and shall got approved from the Competent Authority.

2.12 Preparation of landscaping plan including parks, planters and other details etc. for the horticulture works and execution of same including waste water management system, construction of pump houses and installation of pumps therein etc. complete will be responsibility of selected agency. Development of parks, construction of its boundary wall, providing MS railings (including painting), wicket gates, water hydrants, the grassing, creepers and planting trees etc. shall be completed as per the specification and drawing approved by the Competent Authority.

2.13 Complete leveling/dressing including filling of earth, its supply, disposal of surplus earth is to be completed as directed by the Competent Authority.

2.14 Planning, designing and construction of boundary walls, MS gates, Wicket gates, dustbins, sign boards, guide maps, location boards, direction boards, Numbering of houses etc. all complete as per the drawing approved and direction of Competent Authority.

2.15 Setting up a testing laboratory at site equipped with the apparatus (As per the List of the laboratory equipment given in ANNEXURE-VIIof with this bid document) needed for day to day testing of construction materials during construction period as directed by the Competent Authority.

2.16 Taking all precautionary measures to safeguard safety measures against any accidents for the agency's employees, labour, public, and

staff by providing all necessary safety equipment, helmets etc. at work site.

2.17 The agency shall submit a Model of layout plans and unit plans within one month after award of work. The scale of the model shall be adopted suitably so that all the features are clearly distinguished in the model.

2.18 The scope as described above is only indicative and not exhaustive. In additions to the above the agency shall be responsible for executing all the items required for completing the houses in all respect to make the dwelling units habitable and ready for occupation with electrical, horticultural works complete as per direction of Competent Authority.

2.19 The Environment impact assessment is also a part of the scope of work as such its clearance from Ministry of Environment and Forest Deptt., CPCB & State PCB as applicable is the responsibility of the selected agency. Charges if levied by relevant authority shall be borne by the selected agency.

3.0 General Conditions for Planning & Design

3.1 The selected agency should engage Firms/Consultant (whether titled as an Architectural firm or Engineering firm) which shall provide comprehensive consultancy services in project conceptualization covering space utilization, functional relations, preparation of master plan including obtaining its statutory and local bodies approval, detailed architectural drawings, detailed structural analysis, design and detailing including designing and detailing of all services, their drawings & approval, external development works, landscaping, etc. if in-house consultancy facilities are not available with the selected agency. The cost of consultancy will be borne by the selected agency and separate charges for consultancy shall not be quoted separately.If consultant is hired, consultant shall prepare and supply all the coordinated good for construction drawings duly proof checked and approved. The Consultant shall be associated till completion of the project and obtain completion certificate from the concerned authority.

Such firm / consultant should be an Indian/ foreign consultancy firm and should have in-house Architectural/Engineering capabilities with minimum experience of sevenyears in the similar field.

3.2 The firms/consultants should have completed following consultancy works during the last seven years ending previous day of last date of submission of bid:

3.2.1 Three consultancy works of similar nature each involving built up plinth area of minimum 16,000sqm.,

or

2.2.2 Two consultancy works of similar nature each involving built up plinth area of minimum 24,000sqm.,

or

2.2.3 One consultancy work of similar nature involving built up plinth area of minimum 32,000sqm.,

3.3 The consultancy works completed up to the previous day of last date of submission of bids shall be considered.

3.4 The firms/consultants should have an average annual Financial Turnover of minimum INR1.0 Cr for consultancy fee during immediate last three consecutive fiscal years. For this purpose, average of annual financial turnover shall be worked out for all the three years.

3.5 In case of non-availability of in-house capabilities in consultancy for any component of Engineering services or Architectural services, the firms/consultants will submit intention to engage/associate sub consultant/firms having domain specific specialization and submit the MOU/Agreement with such specialized firms within fortnight of award of work. The Principle/Main consultant shall engage/associate only those sub consultants/firms for consultancy of domain specific components, which have successfully provided consultancy work at least in two projects costing over all more than INR 100 Cr after the approval of Competent Authority.

3.6 The agency shall submit details of financial turnover of firms/consultant in Form 'A' of Technical bid, the details of all consultancy work of consultancy services of similar nature completed by firm/consultant during the last seven years in Form 'C' of Technical bid, performance report of consultancy services in form 'D' of Technical bid, Structure and Organization details in Form 'E' of Technical bid.

3.7 Design Philosophy

3.7.1 Should cover at least the followings:

3.7.1.1 To cater to the different functional requirements of users including their cultural and occupational preferences, through creatively designed indoor spaces, common areas and circulation. Safe pedestrian spaces between community areas, courtyards, and spaces between buildings in a barrier free built environment to encourage community formation.

3.7.1.2 Climate responsive architecture to maximize the use of daylight, ensure thermal comfort, and natural ventilation, shielding, window area disposition, and day lighting to be supplemented with an integrated design of artificial lighting.

3.7.1.3 Optimum utilization of renewable energy sources to be duly integrated in the overall energy system design; with consideration of active and passive aspects in building design including thermal performance of building envelope.

3.7.1.4 Design shall also incorporate renewable resources for power generation for minimum of 5% of total power consumption, provision for installation of solar street lights, solar lighting for common areas, etc. Excess of power generated through renewable resources will be disposed of to grid as per prevailing State Policy.

3.7.1.5 The design basis report shall be submitted by the agency.

3.7.1.6 Integrated designs of electrical, mechanical and other services with structural system which should be planned with optimum cost, low maintenance and lowest consumption of energy and water.

3.7.1.7 The design and construction shall consider the requirements of Rating 3 of GRIHA Affordable Housing Standards.

3.7.1.8 Integrated water and solid waste management with waste water recycling, water conservation and modular rain water harvesting as per CPWD norms.

3.7.1.9 Development of site to be sensitive to topographical features and local vegetation.

3.8 Scope of consultancy work

3.8.1 Architectural Planning and design:

3.8.1.1 Preparation of concept and comprehensive layout plan for the entire area of land confirming to local building bye laws and National Building Code 2016.Architectural

drawings (part of this RFP) are suggestive and for guidance purpose only.

3.8.1.2 To carry out site evaluation and prepare 'Site Zoning' and topropose various options for layout of the proposed buildings, their linkages etc. in consultation MoHUA etc.

3.8.1.3 Preparation of Building Wise Floor plans in 1: 200 or 1: 100 scaleor any other suitable scale as per prior approval of the Competent Authority.

3.8.1.4 Preparation of Elevations and Sections wherever required as per prior approval of the Competent Authority.

3.8.1.5 Preparation of Typical details in 1: 50 or any other scale as per prior approval of the Competent Authority.

3.8.1.6 Preparation of interior design and Room Wise Equipment /furniture layout/furnishing. Equipment layout drawings to be at 1: 100 scale or any other suitable scale as per prior approval of the Competent Authority.

3.8.1.7 Any other designing and detailing required for comprehensive planning and designing of the proposed buildings.

3.9 Structural planning and design:

3.9.1 Framing and preparation of structural system as per proposed technology.

3.9.2 Building/structure wise structural analysis and design using applicable software's.

3.9.3 Preparation of building/structure wise preliminary structural drawings.

3.9.4 Preparation of building/structure wise detailed structural 'Good for construction'sdrawings.

3.9.5 The structural design shall be carried out in terms of latest editions and up-to-date correction/amendment/errata of BIS Codes (Bureau of Indian Standards), other relevant seismic/other codes for making building hazard resistant for hazard such as earthquake, cyclone, flood, landslide or any other natural calamity, sound engineering practices. The agency will get proof checking of structural drawings with IITs or NITs with prior approval of competent authority for proof checking of structural drawings/proposals prepared by the structural sub consultant/main consultant. The fee for proof checking shall be borne by MoHUA. The consultant will liaison and co-ordinate with such Institute approved by Competent Authorityas and when required and as per the direction of Competent Authority.

3.9.6 Submission of all design calculations in hard and soft copies as perthe direction of Competent Authority.

3.10 Services and Miscellaneous Consultancy works

3.10.1 External Bulk services with schematic planning and design like water supply, sewerage system, storm water drains, boundary wall, gates, underground parking, underground water tanks, rainwater harvesting, STP, roads, paths, horticulture, street furniture, paths, differently able person friendly corridors, signage's, Landscape as per green area norms.

3.10.2 Schematic planning and designing of Internal Electrification, fire-fighting system, Lifts, Electric Sub Station building with all equipments and DG Sets, external lighting, solar power generation and any other essential services/ requirement of the Competent Authorityand also required for satisfactory completion of project. The Planning and design should conform to the relevant NBC 2016 and local building bye-laws as applicable.

3.11 Presentations and Models

3.11.1 Preparation of Model(s) to suitable scale decided by Competent Authority.

3.11.2 Preparation of 3D views and blow ups of typical and critical areas and walk through

3.12 Approval from Local Authorities

3.12.1 The agency shall take all necessary statutory approval from all local authorities. Preparation of all submission drawings (any numbers)/materials and models as per the required size/scale as required by local bodies. The State Govt. will facilitate all such fast track statutory approvals.

3.12.2 The agency shall take all necessary statutory approval of 'Completion Plan' from all local bodies as required for occupation of the buildings after completion of construction and preparation of all submission drawings (any numbers)/ materials and models for these approvals.

4.0 Project Management

4.1 The Agency shall prepare the phase wise (monthly) resource chart (materials, manpower and machinery) based on the project execution schedule as mentioned in contract conditions.

4.2 TheAgency shall submit the photographs & videos of progress of work on fortnightly basis to make it possible to create a short film of the entire execution of the work to be kept in archive.

4.3 Agency shall submit a detailed monthly progress & program report to the Competent Authority.

4.4 The Agency will make it possible to be represented by a senior level executive who have sufficient financial powers to take decisions required for completing the project in time.

4.5 The agency shall stick to the construction schedule, if there is any hindrance or delay due to any reason the same shall be mitigatedthrough engaging extra manpower, material and machinery.

4.6 The Agency shall submit every month along with "Progress-Report" the details of "Funds-Requirements" for the next three months.

CONTRACT COORDINATION PROCEDURES, COORDINATION MEETINGS AND PROGRESS REPORTING

The agency shall prepare and finalize in consultation with MoHUA, a detailed contract coordination procedure within 15 days from the date of issue of Letter of Award for the purpose of execution of the contract. The agency shall have to attend all the meetings at any place in India at his own cost with MoHUA or consultants of MoHUA during the period of the contract, as and when required and fully cooperate with such personal and agencies involved during these discussions.

a) A **Project Monitoring Committee (PMC)** will be set up at MoHUA to oversee the entire progress of construction of LHPs at six locations.
b) The PMC shall work out suitable strategy for routine supervision of the projects as felt necessary.
c) The PMC shall meet at least once in a month and will report periodic progress of the project to MoHUA till the handing over of the project to State Government. BMTPC as a Technical partner for GHTC-India, shall provide the necessary technical inputs as per requirements.

Being LHPs, these LHPs will also be evaluated and documented by reputed technical institutions. These studies will be undertaken in consultation with MoHUA and cost of such studies will be borne by MoHUA. The agency will facilitate any visits by such Technical Institutes and provide necessary data.

SECTION-B

Conditions &Specifications of Civil and E&M Works

1.0 General Conditions for Civil Works

1.1 Thework in general shall be carried out in accordance with the CPWD Specifications (corrected up to the last date of submission/uploading of bid) hereinafter referred as CPWD Specifications.

1.2 Agency(s) shall provide permanent bench marks, flag tops and other reference points for the proper execution of work and these shall be preserved till the end of the work. All such reference points shall be in relation to the levels and locations, given in the Architectural and plumbing drawings. On completion of work, the Agency(s) shall submit four prints of "as built" drawings to the Competent Authority.

1.3 The agency (s) should engage approved, licensed plumbers for the work and get the materials (fixtures/fittings) tested, by the municipal Body/Corporation authorities wherever required at his own cost. The agency(s) shall submit for the approval of the Competent Authority, the name of the plumbing agency proposed to be engaged by him.

1.4 The agency shall give performance test of the entire installation(s) as per the specifications in the presence of the Competent Authorityor his authorized representative before the work is finally accepted and nothing extra what-so-ever shall be payable to the agency for the test.

1.5 The work shall be carried out in accordance with the Architectural drawings and structural drawings approved by the Competent Authority.

1.6 Before commencement of any item of work the agency shall correlate all the relevant architectural and structural drawings, and specifications etc. and satisfy himself that the information available is complete and unambiguous. The agency alone shall be responsible for any loss or damage occurring by the commencement of work based on any erroneous and or incomplete information and no claim whatsoever shall be entertained on this account.

1.7 The work of services will be executed simultaneously.

1.8 If the work is carried out in more than one shift or during night, no claim on this account shall be entertained. The agency must take permission from the police authorities etc. if required for work during night hours, no claim/hindrance on this account shall be considered if work is not allowed during night time.

1.9 The agency shall be responsible for the watch and ward/guard of the buildings safety, fittings and fixtures provided by him against pilferage and breakage during the period of installations and thereafter till the building is physically handed over to the department. No extra payment shall be made on this account.

1.10 Sample of building materials, fittings and other articles required for execution of work shall be got approved from the Competent Authoritybefore use in the work. The quality of samples brought by the

agency shall be judged by standards laid down in the relevantCPWD/BIS specifications. All materials and articles brought by the agency to the site for use shall conform to the samples approved by the Competent Authoritywhich shall be preserved till the completion of the work.

1.11 BIS marked materials except otherwise specified shall be subjected to quality test at the discretion of the Competent Authoritybesides testing of other materials as per the specifications described for the item/material. Wherever BIS marked materials are brought to the site of work, the agency shall, if required, by the Competent Authority, furnish manufacturer's test certificate or test certificate from approved testing laboratory to establish that the material/procured by the agency for incorporation in the work satisfies the provisions of specifications/BIS codes relevant to the material and/or the work done.

1.12 The agency shall procure the required materials in advance so that there is sufficient time to testing of the materials and clearance of the same before use in the work. The agency shall provide at his own cost suitable weighing and measuring arrangements at site for checking the weight/dimensions as may be necessary for execution of work.

1.13 Regarding testing of civil & electrical materials, the testing of materials shall be conducted in Govt. Laboratory/Govt. colleges/IITs/NITs or from the laboratory approved by Competent Authority. The charges of testing of materials in approved laboratory shall be borne by the agency.

1.14 Agency shall submit minimum "Quality Assurance" plan within 45days after award of work which shall be consisting of:

1.14.1 Required tests and frequency of components/ products of proposed technology shall be as per national/ international standards as applicable for proposed technology.

1.14.2 Lot-size, number of required tests and frequency of testing. While deciding these criteria CPWDspecifications &provisions of BIS Code and standard practices may be referred. Volume of work, practical difficulties and site conditions etc. may also be kept in view. The lot size, number of tests and frequencies of testing can be altered or modified by the Competent Authority from the prescribed limits.

1.14.3 It should clearly indicate the machinery and other Tool &plants required to be deployed at site by the agency. Entire machinery and T&P may not be required at the start of work, therefore, a proper time schedule by which each machinery andT&P is to be brought at site should also be indicated.

1.14.4 Receipt of Material, testing of the same &maintenance of Register of Tests.

1.14.5 All the registers of tests carried out at construction site or in outside laboratories shall be maintained by the agency,which may be inspected by Competent Authorityor his/her designee at any point of time.

1.14.6 The agency shall allow access to Third Party Quality Assurance Agency (TPQAA) engaged by Competent Authorityto have a control on quality and methodology of execution. At least 25% of samples of materials including cement concrete cubes shall be taken jointly byAgencyandTPQAA/Competent Authorityor his authorized representative. All arrangements for transporting and getting them tested shall be made by the agency.

1.14.7 All the test in field lab setup at construction site shall be carried out by the Quality control team to be engaged by the agency whichcan be witnessed by Competent Authorityor his/her designee. A daily report of Tests to be conducted on a day shall be submitted to Competent Authorityor his/her designee.

1.14.8 All the entries in the registers will be made by the designated Engineering Staff of the agency.

1.14.9 Agency shall be responsible for safe custody of all the test registers.

1.14.10 Submission of copy of all test registers, material at site register andhindrance register along with each alternate running account bill and finalbill shall be mandatory.

1.15 Method Statement

1.15.1 The agencyshall submit a 'Methods statement' for each important activity for the approval of the Competent Authoritysoon after the award of work to him. The 'Methods statement' is a statement by which the construction procedures for any activity of construction are formulated and stated in chronological order. The 'Methods statement', should have a description of the item with elaborate procedures in steps to implement the same, the specifications of the materials involved, their testing and acceptance criteria, equipment to be used, Precautions to be taken, steps of measurement, etc.

1.16 Check-list for Execution of work

1.16.1 As and when any important item is taken up for execution, the agency shall submit the specifications and develop a checklist and other relevant details. This sample checklist should be got approved from the Competent Authorityand should be used at site. This check list should be shown to the Competent Authorityor his/her designee during inspection. This procedure is not restricted to the proposed technology and its components but also to be followed for all hidden items,CC/RCC work, Steel-reinforcement, shuttering, cast-in-situ mosaic flooring, doors & windows, plumbing, including water supply pipe lines, roof treatment, earth filling etc.

1.16.2 The agency shall be responsible forall documenting the total sequence of this project by way of photography, slides, audio-video recording etc. nothing extra shall be payable to the agency on this account.

1.16.3 General

The agency shall acquaint himself with the proposed site of work, its approach roads, working space available before quoting his rates.

i. No Entry/exit/roads other than specified by the Competent Authorityfor purpose of construction activities will be allowed to be used for construction activity purposes or movement of trucks/lorries/load-carriers and nothing extra/delay whatsoever will be accounted for on this part.

ii. No payment shall be made for any damage caused by rain, snowfall, flood or any other natural calamity, whatsoever during the execution of the work. The agency shall be fully responsible for any damage to the govt. property and work for which the payment has been advanced to him under the contract and he shall make good the same at his risk and cost. The agency shall be fully responsible for safety and security of his material, T&P, machinery brought to the site by him.

iii. The agency shall ensure that no construction leachate (e.g. cement slurry etc.), is allowed to percolate into the ground. Adequate precautions are to be taken to safeguard against this including, reduction of wasteful curing processes, collection, basic filtering and reuse. The agency shall follow requisite measures for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas. Temporary drainage channels, perimeter dike/swale, etc. shall be constructed to carry the pollutant-laden water directly to the treatment device or facility (municipal sewer line).

iv. The agency shall comply with the safety procedures, norms and guidelines (as applicable) as outlined in the document Part 7 Constructional Practices and Safety- 2016, National Building code of India and Bureau of Indian Standards. A copy of all pertinent regulations and notices concerning accidents, injury and first-aid shall be prominently exhibited at the work site. Depending upon the scope & nature of work, a person qualified in first-aid shall be available at work site to render and direct first-aid to causalities. A telephone may be provided to first-aid assistant with telephone numbers of the hospitals displayed. Complete reports of all accidents and action taken thereon shall be forwarded to the competent authorities

1.16.4 The agency shall ensure the following activities for construction workers safety, among other measures:

i. Guarding all parts of dangerous machinery.

ii. Precautionary signs for working on machinery.

iii. Maintaining hoists and lifts, lifting machines, chains, ropes, and other lifting tackles in good condition during the defect liability period.

iv. Ensuring that walking surfaces or boards at height are of sound construction and are provided with safety rails or belts.

v. Provide protective equipment; helmets etc.

vi. Provide measures to prevent fires. Fire extinguishers and buckets of sand to be provided in the fire-prone area and elsewhere.

vii. Provide sufficient and suitable light for working during night time.

1.16.5 The agency shall provide for adequate number of garbage bins around the construction site and the workers facilities and will be responsible for the proper utilization of these bins for any solid waste generated during the construction. The agency shall ensure that the site and the workers facilities are kept litter free. Separate bins should be provided for plastic, glass, metal, biological and paper waste and labeled in both Hindi and English with suitable symbols.

1.17 Conditions for environment protection

1.17.1 The agency shall not store/dump construction material or debris on the metalled road.

1.17.2 The agency shall get prior approval from Competent Authorityfor the area where the construction material or debris can be stored beyond the metalled road. This area shall not cause any obstruction to the free flow of traffic /inconvenience to the pedestrians. It should be ensured by the agency that no accidents occur because such permissible storage.

1.17.3 The agency shall ensure that all the trucks or vehicles of any kind which are used for construction purposes/or are carrying construction material like material like cement, sand and other allied material are fully covered. The agency shall take every necessary precaution that the vehicles are properly cleaned and dust free to ensure that enroute their destination, the dust, sand or any other particles are not released in air/contaminate air.

1.17.4 The agency shall provide mask to every worker working on the construction site and involved in loading, unloading and carriage of construction material and construction debris to prevent inhalation of dust particles.

1.17.5 The agency shall comply all the preventive and protective environmental steps as stated in the MoEF guidelines 2010 and / or any other guidelines issued later on.

1.17.6 The agency shall carry out on- road-inspection for black smoke generating machinery. The agency shall use cleaner fuel.

1.17.7 The agency shall ensure that all DG set comply emission norms notified by MoEF.

1.17.8 The agency shall use vehicles having pollution under control certificate. The emissions can be reduced by a large extent by reducing the speed of a vehicle to 20Kmph. Speed bumps shall be used to ensure speed reduction. In case where speed reduction cannot effectively reduce fugitive dust, the agency shall divert traffic to nearby paved areas.

1.17.9 The agency shall ensure that the construction material is covered by tarpaulin. The agency shall take all other precaution to ensure that no dust particles are permitted to pollute air quality because of such storage.

1.17.10 The paving of the path for plying of vehicles carrying construction material is more permanent solution to dust control and suitable for longer duration projects.

1.17.11 It is mandatory to use of wet jet in grinding and stone cutting.

1.17.12 The Agency shall take appropriate protection measures like raising wind breakers of appropriate height on all sides of the plot/area using CGI sheets or plastic and / or other similar material to ensure that no construction material dust fly outside the plot area.

1.17.13 Any violation of orders of MoEF including guidelines of State Government, SPCB or any officer of any department shall lead to stoppage of work for which Agency shall be responsible and no hindrance shall be accounted in this regard.

1.18 Miscellaneous

1.18.1 A sample flat with proposed technology shall be made ready before starting the execution. The flat should be furnished complete in all respect with doors and windows including fittings, painting, hardware, flooring, painting, electrical services, etc. Nothing extra shall be paid for the sample flat. In case it is not possible to construct sample flat with proposed technology in isolation, the sample flat may be constructed within the tower.

1.18.2 Agency shall arrange water for construction from its own sources within the ambit of laws and guidelines issued by the competent authority in this regard. Effort should also be made by selected agency for using recycled water for construction.

2.0 Specifications for Civil Works

2.1 The broad specifications of shortlisted technologies to be used for construction of LHPs are mentioned in **Section F** and need to be followed. As regards procurement and use of cement, steel reinforcement, design mix concrete from batching plant/RMC Plant, etc. and any other required material shall be as per applicable CPWD specifications, relevant Indian Standards and this RFP.

2.4 Waterproofing

2.4.1 The work shall be got executed from the specialized agency as approved by the Competent Authority.

2.4.2 Agency shall also submit the names of water proofing specialist along with information about their technical capabilities and list of similar works executed by the specialized agency in the past for the approval of Competent Authority within 30 days from the date of award of work who have executed satisfactorily a minimum of three works of value not less than 40% of total work of water proofing to be executed each or two works of value not less than 60% of total work of water proofing to be executed each or one work of value not less than 80% of total work of water proofing to be executed in the last seven years.

2.4.3 Total quantity of the water proofing compound required shall be arranged only after obtaining the prior approval of the make by Competent Authorityin writing. Materials shall be kept under double lock and key and proper account of the water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements.

2.4.4 The finished surface after water proofing treatment shall have adequate smooth slope as per the direction of the Competent Authority.

2.4.5 Before commencement of treatment on any surface, it shall be ensured that the outlet drain pipes / spouts have been fixed and the spout openings have been eased and rounded off properly for easy flow of water.

2.4.6 The approved specialized agency for the work of water proofing will have to execute a guarantee bond in prescribed Proforma enclosed atANNEXURE-IXfor removing any defects for at least 10 years. Guarantee bond shall be signed by both the specialized agencies as approved by the Competent Authorityand the agency to meet their liability under the guarantee bond. However, the sole responsibility about the efficiency of water proofing treatment shall rest with the agency.

2.4.7 10% of the cost of water proofing work shall be retained as additional security deposit and the amount so withheld would be released after ten years from the date of completion of the entire work under the agreement. If the performance of the work done is found unsatisfactory and any defects noticed during the guarantee period, they shall be rectified by the agency within seven days of receipt of intimation of defects in the work. If the defects pointed out are not attended to within the specified period, the same will be got done from another agency at the risk and cost of the agency.

3.0 General Scope &Specifications of E&M works

3.1 Scope of work

3.1.1 Scope of work covers planning, designing, supply, installation, testing and commissioning of all E&M services such as IEI, Fire Fighting, Fire alarm, D.G. Sets, Lifts, Aviation Light required to be provided in the said scheme as per norms of various IS codes /NBC 2016/CPWD specifications/ECBC/CEA, various byelaws and norms of local bodies. The work shall be executed as per scope & specifications of E & M works given hereafter and given in respective head/part of the scheme sub-head. If any services required to make the building /scheme habitable is not covered in the scope of services same shall either be pointed out in pre-bid meeting else, it shall be presumed that the same shall be provided within the quoted cost and nothing extra shall be paid on this account.

3.1.2 The scope of works also covers the preparation of layout plans, drawings for E&M schemes and approval of the same from the respective local bodies/CFO etc. before the commencement of work. During execution, if the local bodies etc. require a modification, the same shall be executed without any extra cost. Finally, after execution, approvals/NOCs/clearances from local bodies etc. shall be the responsibility of successful agency for which nothing extra is payable in case any modification/ extra work is required. All statutory fees/charges required for obtaining clearances from CEA/Local Bodies shall be paid by the agency.

4.0 General

4.1 These additional terms & conditions are applicable to all the E&M works.

4.1.1 The Agency shall submit within 15 days after award of work an undertaking from the Original Equipment Manufacturers (OEMs) for specialized E&M works regarding:

A) The OEMs shall unconditionally support the lowest agency technically throughout the execution of contract as well as for maintenance/comprehensive maintenance contract for the useful life of the system, and

B) OEMs shall provide all the spares required for healthy functioning of the equipment for at least seven years or useful life of the system whichever is later from the date of supply of equipment. For the above purpose, undertaking may be submitted by OEMs.

4.1.2 The agency must study specifications and conditions carefully. The work shall be executed in close coordination with the progress of building work.

4.1.3 The work shall be carried out as per CPWD specifications, if specifications are not available, IS codes shall be followed.

4.1.4 All equipments shall be delivered with (i) manufacturer's test certificate, (ii) manufacturer's technical catalogues, and installation / instruction (O&M) manuals.

4.1.5 Scaffolding & any other T&P required for execution of work shall be arranged by the agencies and nothing extra shall be payable on that account.

4.1.6 The layout plans/drawings/other documents pertaining to E&M services shall have to be submitted for evaluation & approval, within 45days of award of work.

4.1.7 Statutory fees/ payments to Govt. bodies required to be deposited for processing the case, shall be reimbursed by MoHUA on production of actual bills from the concerned department.

5.0 Inspection before Dispatch

All routine tests shall be conducted before dispatch of equipments. No equipment shall be dispatched from the manufacture's premises without such tests being conducted and test result recorded. These test certificates shall be given along with the supply of equipments. The Engineer In-Charge shall, if he so desires inspect and witness the pre-delivery tests. For this purpose, the agency shall give 15 days' notice. Agency shall arrange for inspection by the department. Department shall bear expenses of its officials for inspection as far as traveling, boarding and / lodging is concerned. However, waiver if any, for inspection shall be at the discretion of the department without any cost implication but ROUTINE TEST & TYPE TEST certificates shall have to be submitted for equipments.

Prior to dispatch, all equipments shall be adequately protected & insured for the whole period of transit, storage and erection against corrosion and incidental damages etc. from the effect of vermin, sunlight, rain, heat and humid climate.

6.0 Insurance

The agency shall include storage cum erection insurance including third party insurance right from the storage to commissioning of various equipments. All insurance which the agency is required to enter under the contract shall be affected with any authorized general insurance company and the agency shall produce the policies of insurance.

7.0 Remedy of failure to insure

If the agency fails to effect and keep in force the insurance referred to in the preceding sub-clause the department may affect and keep in force any such insurance and pay such premium as may be necessary for that purpose and from time to time deduct the amount, so paid by the department, from any money due or which may become due to bids or recover the same as debit from the agency's bill.

8.0 Quality of material and workmanship

All parts of the equipment shall be of such design, size and material to function satisfactorily under all rated conditions of operation. All

components of the equipments shall have adequate factor of safety. The work of fabrication and assembly shall conform to sound engineering practice and based on "Fail Safe Design". The mechanical parts subject to wear and tear shall be easily replaceable type. The construction of the equipments shall be such as to facilitate effortless operation, inspection, maintenance and repairs. All connections and contacts shall be designed to minimize risk of accidental short circuits caused by animals, birds and vermin etc. All identical items and their component parts should be completely, interchangeable including spare parts.

9.0 Inspection and testing at site

9.1 The installation shall be subject to necessary inspection during every stage of erection, by the Competent Authority. The successful agency shall provide all facilities and assistance for the purpose.

9.2 The completed installation shall be inspected and tested by the Competent Authorityin the manner as will be laid down by him, in consultation with the agency.

9.3 All instruments and facilities necessary for the tests shall be provided by the agency.

10.0 Completeness of work

10.1 The installations shall be completed in all respects and put in to operation even where certain details have not been mentioned/left out in these specifications. Any discrepancy may be brought out in pre-bid meeting.

10.2 All E&M services such as Internal Electrical installations, lifts, fire fighting system & Addressable fire alarm system shall be declared as completed after completion of trial run of 1 month.

11.0 Internal electric installation (IEI)

11.1 The work will be carried out as per proposed technology specifications for the internal electric installation. Where such specifications are not available, CPWD specifications shall be adopted.

11.2 FRLS PVC insulated Copper conductor wires will be used for points, circuit & sub-main wiring.

11.3 Agency shall execute the work as per scale of amenities given elsewhere in document after obtaining necessary approval of the layout for internal electrification of all houses, common areas and staircases from Competent Authority. The staircase lighting shall be in group control system.

11.4 Modular type switches, sockets and stepped type electronic fan regulators, bell push along with matching mounting boxes of same make shall be used.

11.5 TV outlet point wiring of each house shall be terminated in suitable size of G.I. box along with splitter at every floor. The interconnections of all splitter boxes fixed at all floors shall be done properly with

conduits to form proper distribution system with the prior approval of competent authority.

11.6 Suitable rain protection covers made of 16 SWG galvanized MS sheet wherever required shall be provided.

11.7 Meter Boards & Main Distribution Boards as per DISCOM specification/requirement shall also be provided by the agency. Dwelling units shall be provided with single phase 230 V supply.

11.8 A separate Meter Rooms for each block of houses is to be provided at suitable location in the housing block with the prior approval of layout by Competent Authority.

11.9 Separate shaft for each block of houses shall be provided for laying of Electrical, mechanical & fire services. HDPE/DWC pipes for taking L.T. cables up to meter boards in the meter rooms along with brick masonry chambers of suitable size shall be provided by the agency wherever required.

11.10 Laying of HDPE / DWC /Hume pipes for road crossing or in pucca portion & CC path etc. for electric/street lighting cables complete with adequate number of cable chambers shall be provided by the agency.

11.11 After completing the work, necessary test results as envisaged in CPWD General Specifications Part-I (Internal)-2005&Indian Electricity Rules 2005, shall be recorded and submitted to MoHUA. The results shall be within the permissible limits. Test report forms duly signed by authorized person for obtaining electric connections (energy meters) from Power Distribution Company by the agency shall be given to the allottees.

11.12 Lightning arresters as per IS; 2309 -1989 as amended upto date shall also be provided by successful agency.

12.0 Installation of lift

12.1 Provision of lifts in the housing scheme will be kept as per National Building Code-2016/CPWD Specifications considering no of floors, height of the building and speed of elevators which shall be submitted to Competent Authorityfor approval before commencement of work.

12.2 Scope of work of the successful agency shall be inclusive of the following and shall be done by the agency at no extra cost.

12.3.1 Provision of proper ventilation in machine rooms, lift wells and water proof lift pits including lighting.

12.3.2 Electric supply to individual lift shall be given by two independent feeders (one working & other stand by) from main electrical panel through change over switch in the machine room /ground floor panel room.

12.3 Agency shall furnish the following drawings and data to the Competent Authorityin triplicate, for approval.

12.4.1 General arrangement drawing.

12.4.2 Detail of foundations for equipment, load data of various assembled equipments. Data will include breaking load on guides, reactions on buffers, reaction on support in machine room, lift well etc.

12.4.3 Dimensions for every unit and group of units for erection purpose, as required.

12.4.4 The correction/changes, if any, intimated by the Competent Authorityshall be incorporated and three sets of such corrected drawing shall be furnished to the Competent Authoritywithin 15 days from the date of approval of drawings. The work shall be executed in accordance with the approved drawings.

12.4 Inspection and Testing at Site:

12.5.1 The lift installation shall be subject to necessary inspection during every stage of erection, by the Competent Authorityor his authorized representative. The bids shall provide all facilities and assistance for the purpose.

12.5.2 On completion of the installation, all adjustments as necessary shall be made for the satisfactory performance of the lifts. The completed installation shall be inspected and tested by the Competent Authorityin the manner as will be laid down by him, in consultation with the agency.

12.5 Technical Specification

The lift shall work on microprocessor based control system with self-diagnostic features, site programming to suit the changing need of the user. The lift shall be silent in operation & shall have smooth and controlled acceleration and de-acceleration with leveling accuracy of +5 mm.

12.6 Technical Particulars

12.7.1 Type of lift.

12.7.2 Rated Speed & Rated load shall be as per approval of Competent Authority.

12.7.3 Type of operation: Automatic group supervisory control with/without attendant.

12.7.4 Type of control: A.C. drive variable voltage variable Frequency with Microprocessor based group control system.

12.7.5 Type car doors: Centre opening stainless steel sliding door in the moon rock finish.

12.7.6 Door Operation: Automatic power operated Construction design & Stainless body with moon rock “honey comb finish” finishing of car body on 3 sides and plain finish on front side shall be given. The car shall be complete with PVC flooring & toe guard of adequate depth cabin fan light fittings with lamps and false

ceiling. Stainless steel hand rails shall also be provided on 3 sides. Disabled friendly lift in each lobby shall be suitable for handicapped persons. (For this purpose, the railing and controlling switchetc. shall be fixed at theappropriate height.

12.7.7 Type of signal system: All signal & operating fixtures shall be provided with stainless steel face plates.

12.7.8.1 Call registration indication in buttons of operating panel.

12.7.8.2 Digital car position indicator in car.

12.7.8.3 Digital car position indicator with up & down direction on all floors separately for each lift.

12.7.8.4 Luminous hall call buttons on all floors.

12.7.8.5 Maintenance free re-chargeable battery operated alarm bell & emergency light.

12.7.8.6 Fire man's switch at ground floor for each group of passenger lift.

12.7.8.7 Over load warning with visual indication 'OVER LOADED' and audio beep of overloading

12.7.8.8 Voice announcement system having standard features.

12.7.8 Intercom system in each lift for communication between the passengers in the elevator & fire control room & machine room (press & speak type) with rechargeable maintenance free battery backup.

12.7.9 Elevator should be equipped with manual as well as automatic rescue devices.

12.7.10 Infra red beam type door safety device shall be provided for full height of door.

13.0 Fire fighting& Fire alarm system

13.1 Fire Protection System shall be designed and provided as per NBC 2016 with Amendments, Updated BIS Codes& Fire Bye Laws. NOC for the scheme from Local Fire Service Department shall be obtained by the agency.

14.0 DG set

14.1 DG Sets Installation

14.1.1 DG sets outdoor type with radiator cooled, as per CPWD Specifications for Electrical Works.DG Set shall be within an acoustic hood as per CPCB norms. Each DG Set shall be provided with its own day oil tank suitable for at least 10 hrs operations.

14.1.2 Standby Power Generation.

14.1.3The capacity of DG set should be worked out with following consideration:

i. Total connected Electrical Loads of Common Services viz Staircase light, Lifts, Drinking Water Pumping Sets, External Lighting, Sentry Posts, Mechanical Ventilation.

ii. Power Factor – 0.80.

iii. Provision for Future expansion / addition – 2% of the connected load
iv. The diversity factor to be, as per the National Electric Code 2011 or latest.
v. Loading factor.
vi. DG Sets shall be 400V, 3 Phase, 4 wire, 50Hz, 0.8 PF with acoustic enclosure.

14.2 DG Set Flue Stack

14.2.1 As per CPCB norms, flue pipes of DG Sets need to be taken above the roof top of the building, as per CPWD General Specifications for Electrical Works Part VII DG Set – 2013,

14.2.2 The flues shall be adequately thermally insulated and properly cladded so as to prevent heat transfer to the supporting walls and adjacent areas.

14.2.3 DG exhaust shaft shall be required for the purpose of installing flue pipes for taking them above roof top.

14.2.4 DG Set Start/ Stop & change over shall be fully automatic

14.2.5 DG sets shall start automatically within 10-30 seconds in the event of a power failure and shall transfer power to emergency/ critical loads automatically.

14.2.6 DG Sets operation shall incorporate:

i. Auto Start / Stop of DG Sets i.e. auto mains failure.
ii. Auto Transfer of Load

14.3 External / Landscape Lighting

14.3.1 Security Lights, Road Lighting, open area lighting shall be provided as per codal& functional requirements.

14.3.2 Pathways, Garden, Water Bodies & Landscape lighting shall be designed keeping in mind Architectural features/Aesthetic considerations.

14.3.3 As a general practice, following type of fixtures/poles shall be used as per CPWD specifications applicable.

Area / Space	Average Illumination Range in Lux	Type of Lamps / Fixtures
Boundary Wall, Road, Parking, Areas	30 – 50 - 100 Lux	LED Lamps Street light fixtures Mounted on 6 to 7m High Octagonal Powder Coated poles.
Pathways, Garden, Water Bodies &Landscape lighting	Aesthetical Consideration	Bollards with LED's / Other Luminaries, as per aesthetical Consideration

15.0 Approved makes

Apart from the proposed technology the following specification/brands names of materials to be used as listed wherever required. The efforts should be made by the agency to use indigenous products. The agency should also consider the availability of spares parts/components for maintenance purposes while proposing any brand/manufacturer. The materials of any other brand/manufacturer may be proposed for use by the agency in case the brands specified below are not available in the market and/or agency intends to use some other brand better than the brands mentioned in this list. The alternate brand can be used only after the approval of Competent Authority. The list of approved make for Civil Works is given below:

Sl. No	**Materials**	**Approved make**
For Civil Works		
1.	PPC / OPC CEMENT	ACC / ULTRATECH / AMBUJA / JK BIRLA
2.	WHITE CEMENT	J.K. WHITE / BIRLA WHITE / TRAVANCORE
3.	REIN FORCEMENT STEEL	TATA / SAIL / JINDAL STEEL / RINL
4.	STRUCTURAL STEEL SECTIONS	SAIL / TATA STEEL Ltd. /RINL AND JINDAL STEEL & POWER Ltd
5.	AAC BLOCK	BUILTECH / MAGICRETE BUILDING SOLUTION / AEROCON/INDO BHUTAN CONSTRUCTION SOLUTION
6.	AAC BLOCK ADHESIVE	ULTRATECH / FERROUSCRETE / BAL ENDURA
7.	POLYMER MODIFIED CEMENTITIOUS GROUT	BAL ENDURA / WEBBER / MYK LATICRETE
8.	EPOXY MORTAR	FOSROC / SIKA / CICO / LATICRETE
9.	FLUSH DOORS	GREEN / DURO / MERINO / MAYUR / ARCHID / KUTTY
10.	UPVC WINDOWS/ DOORS / VENTILATORS	ENCRAFT / ALUPLAST / REHAU / DUROPLAST
11.	WOODEN / METAL / GLAZE- FIRE RATED DOOR SHUTTERS	NAVAIR / SUKRI / PROMAT / KUTTY /BHAWANI / PACIFIC
12.	HINGES & BRASSWARE	SHALIMAR/ INDO-BRASS / AMARBHOY DOSSAJI / EARL BIHARI / MAGNUM/KICH

13.	ALL TYPES OF GLASS	AIS / MODIGUARD / PILKINGTON / GLAVERBEL / SAINT GOBBIN
14.	FIRE-RATED GLASS (TWO HOUR FIRE RATING) TRANSPARENT CLEAR GLASS	GLAVERBEL / SAINT GOBBIN / PYROGUARD / SHOTT
15.	ALL HARDWARE AND FITTINGS FOR ALL TYPES OF GLAZING / DOORS / WINDOWS ETC.	DORMA / HAFELE / GEZEI / KICH / GODREJ / ASSA-ABLOY
16.	ADHESIVES	ANCHOR / DUNLOP / PIDILITE-FEVICOL
17.	STAINLESS STEEL DOOR HANDELS / LOCKS AND FITTINGS	DORMA / HAFELE / GEZE / GODREJ / KICH / IPSA / ASSA-ABLOY
18.	SS MESH	GKD / WMW
19.	COMMERCIAL PLY / BOARD	DURO / CENTURY / ARCHID / DURIAN
20.	HARDWARE ACCESSORIES FOR FIRE DOORS / PANIC BAR / PANIC TRIM / DOOR CLOSER / HINGES / MORTISE LOCK	INDERSOLL ROND / DORMA/ GEZE / HAFELE / ASSA-ABLOY / KICH
21.	VITREOUS CHINA WARE	HINDWARE / PARRYWARE / CERA / JOHNSON / KEROVIT
22.	RCC PIPES	PRAGATI / LAKSHMI / SOOD & SOOD / JAIN & CO
23.	UPVC / CPVC PIPES & FITTINGS	SUPREME / PRINCE / ASTRAL / FINOLEX / SURYA ROSHNI / ASHIRWAD
24.	STAINLESS STEEL SINKS	NEELKANTH / NIRALI / CERA
25.	SPUN CAST IRON PIPES & FITTINGS (IS:3989)	JAISWAL NECO/ RIF / SKF / BIC
26.	STONEWARE PIPES AND GULLY TRAPS	PERFECT / BURN / ANAND / PARRY
27.	GUNMETAL VALVES (FULL WAY VALVE) CLASS-I	ZOLOTO / CASTLE/ KARTAR
28.	CI DOUBLE FLANGED SLUICE VALVE	KIRLOSKAR / IVC / SONDHI / KEJRIWAL

29.	CI MANHOLE FRAME & COVERS AND CI GRATING	NECO / RIF / SKF / BIC
30.	SANITARY CP FITTINGS & ACCESSORIES	ORIENTAL SERIES OF MARC OR EQUIVALENT SERIES OF JAQUAR / PARRYWARE / GROHE / KOHLER
31.	FLOOR TRAPS	JAYNA / CHILLY / NIRALI
32.	PVC WATER TANK	SINTEX / POLYCON / SPL.
33.	CERAMIC TILES / VITRIFIED TILES	H & R JOHNSON / SOMANY / KAJARIA / ASIAN (AGL)
34.	SYTHETIC ENAMEL PAINT / PRIMER / DISTEMPER / EXTERIOR DECORATIVE PAINT	1st QUALITY PRODUCTS OF: ASIAN / BERGER / ICI (DULUX) / NEROLAC
35.	WALL PUTTY / COURSE PUTTY	1st QUALITY PRODUCTS OF: BIRLA WHITE / J.K WHITE / FERROUS CRETE / BERGER
36.	TILE ADHESIVE / EPOXY GROUTS	FERROUS CRETE / BALLL ENDURA / PIDILITE / LATI CRETE
37.	PAVERS / GRASS PAVERS / KERB STONE	UNISTONE / ULTRA / HINDUSTAN / K.K.
38.	BUILDING SIGNAGE	HINDUSTAN SIGNAGE PVT.LTD / PR GRAPHICS / MOTIVATTE SOLUTION / GALAXY SIGNAGE, SIGNSUTRA
39	Structural Steel	SAIL,RINL,TATA STEEL, JINDAL, ESSAR OR AS APPROVED BY CLIENT(BMM ISPAT LTD)
40	Electrodes	ADOR (ADVANIORLIKON), D & H, ESAB OR EQUIVALENT APPROVED MANUFACTURES AS APPROVED BY CLIENT(BMMISPATLTD).
41	Paint	BERGER, SHALIMAR, AKZO-NOBEL,SIGMA COATING, ASIAN PAINTS, GRAND POLYCOAT OR AS APPROVED BY BMM ISPATLTD.

	For Electrical Works	
1.	FRLS PVC insulated copper wire /Power cable / XLPE Cable / Telephone cable	L&T / HAVEL'S / POLYCAB / FINOLEX / SKY TONE.
2.	Co-axial TV cable	L&T / HAVEL'S / POLYCAB / FINOLEX / SKY TONE.
3.	Steel Conduit	RM CON / AKG / BEC ISI MARKED.
4.	PVC Conduit	AKG / POLYCAB / PRINCE ISI MARKED.
5.	L. T. Panel / Meter Board	ADLECMUNDKA / ASSOCIATED SWITCHGEARS AND PROJECT LTD. / SUDHIR GENSET LTD. / CONTROL AND SWITCHGEARS PVT. LTD / KEPL /TRICOLITE
6.	MCB/MCB DB, prewired MCB DB and sheet steel Metal enclosed industrial socket, plug top and Isolators	LEGRAND / SIEMENS / L&T / ABB / SCHNEIDER
7.	Modular type switch/Socket, Telephone socket, cable TV Antenna socket, Electronic fan regulator and GI Boxes	LEGRAND (MYLINC / HAVEL'S (PICCADILLY) / HONEYWELL (MIDAS) /NORTH WEST (NOVA)
8.	LED fitting	PHILIPS / CROMPTON / WIPRO / GE / ZUMPOBEL / TRILUX
9.	Ceiling Fan / Exhaust fan	CROMPTON GREAVES / ALMONARD / HAVELLS / USHA.
10.	Octagonal steel pole	BAJAJ/ TWINKLE / VALMART
11.	Air Circuit Breaker / MCCB.	L&T-U POWER / SIEMENS-3WL / ABB-EMAX / SCHNEIDER-MASTERPACT-NW
12.	Fire Extinguishers	SAFEX/ MINIMEX / SUPEREX / CEASFIRE
13.	Diesel operated Power Generating Engine	CUMMINS INDIA / CATERPILLAR / PERKINS / KOEL GREEN
14.	Alternator	STAMFORD / LEROY SOMER / CATERPILLAR / KOEL GREEN
15.	LIFTS	1. M/S OTIS 2. M/S KONE 3. M/S MITSUBISHI

		4. M/S SCHINDLER 5. M/S JOHNSON LIFTS PVT. LTD. CHENNAI
16.	Copper Conductor Control Cable	BONTON / LAPP CABLE / HAVELLS / RR KABEL / L&T / RAJNIGANDHA
17.	Communication Cable / Signal Cable	LAPP CABLE / FUSION POLYMER / BELDON
18.	Fire / Sprinkler Main Pump / Jockey Pump	MATHER & PLATT INDIA LIMITED / GRUNDFOS / KIRLOSKAR / KSB
19.	Diesel Engine	CUMMINS / KIRLOSKAR / CATEPILLAR
20.	Motor	ABB/ SIEMENS/ KIRLOSKAR / CROMPTON GREAVES
21.	Anti Vibration Mounting	KANWAL INDUSTRIAL CORPORATION/ RESISTOFLEX / EWREN
22.	Starter	L&T/ SIEMENS / CROMPTON/ GE / ABB / BCH
23.	Addressable Multicriteria Smoke Detectors With base / Addressable Duct Type Smoke Detectors With base/ Fault Isolator with base/ Addressable Heat Detectors with base/ Addressable Manual Call points / Addressable Control Module / Addressable Monitor Module / Sounder/ Hooter cum Strobe/ Fire Alarm Control Panel/ PA System Panel/ Telephone Jack / Hand Set/ Software/ Speaker	NOTIFIER / SIEMENS / BOSCH / EDWARD.
24.	Fireman Axe/ Installation Control Valve	SAFEX/ PADMINI / GETECH
25.	2-way/4-way FBC	SAFEX/ NEWAGE (MUMBAI) / GETECH
26.	Window Sprinkler	TYCO / HD
27.	Deluge Valve	SAFEX/ TYCO / HD
28.	Air release valve	SUPEREX/ GETECH / NEWAGE / SAFEX

ANNEXURE-IX

GUARANTEE TO BE EXECUTED BY AGENCY FOR REMOVAL OF DEFECTS AFTER COMPLETION IN RESPECT OF WATER PROOFING WORKS

The agreement made this……day of year two thousand and ……between …… (Hereinafter called the Guarantor of the one part) and the PRESIDENT OF INDIA (Hereinafter called the Government of the other part).

WHEREAS THIS agreement is supplementary to a contract (Hereinafter called the contract) dated …… and made between the GUARANTOR OF THE ONE PART AND the Government of the other part, whereby the agency inter-alia, undertook to render the building and structures in the said contract recited completely water and leak proof.

AND WHEREAS THE GUARANTOR agreed to give guarantee to the affect that the said work will remain water and leak proof for ten years from the date of giving of water proofing treatment.

NOW THE GUARANTOR hereby guarantee that water proofing treatment given by him will render the structures completely leak proof and the minimum life of such water proofing treatment shall be ten years to be reckoned from the date after the maintenance period prescribed in the contract.

Provided that the guarantor will not be responsible for leakage caused by earthquake or structural defects or misuse or alteration and for such purpose.

a) Misuse of roof shall mean any operation which will damage proofing treatment, like chopping of firewood and things of the same nature which might cause damage to the proof.
b) Alteration shall mean construction of an additional storey or a part of the roof or construction adjoining to existing roof whereby proofing treatment is removed in parts.
c) The decision of the Competent Authority with regard to nature and cause of defects shall be final.

During this period of guarantee, the guarantor shall make good all defects and in case of any defect being found render the building water proof to the satisfaction of the Competent Authority at his cost and shall commence the work for such rectification within seven days from the date of issue of the notice from Competent Authority calling upon him to rectify the defects failing which the work shall be got done by the Department by some other agency at the Guarantors risk and cost. The decision of the Competent Authority as to the cost payable by the Guarantor shall be final and binding.

That if guarantor fails to execute the water proofing or commits breach there under; then the guarantor will indemnify the Principal and his successors against all loss, damage, cost any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/ or damage and/or cost incurred by the Government, the decision of the Competent Authority will be final and binding on the parties.

IN WITNESS WHEREOF these presents have been executed by the obligator .... and .....By..... For and on behalf of the PRESIDENT OF INDIA on the day, month and year first above written.

SIGNED, sealed and delivered by OBLIGATOR in the presence of :

1. ..... 2. .....

SIGNED FOR AND ON BEHALF OF MoHUA
By ..... in the presence of :

1. ..... 2. .....

SECTION-C

Architectural Design Norms, Schedule of Finishes &General Specifications

1.0 Norms Applicable & Scale of Amenities for Residential Units

1.1 Plinth Area

The following norms (variation +2%) shall be adopted for Residential Units:

S. No	Type	Unit Carpet Area (Main)	Staircase/ Circulation	Balcony	Utility area/Balcony
		Sqm	Sqm	Sqm	Sqm
1.	EWS	As per designs following NBC 2016 norms and guidelines of PMAY(U)			

2.0 Scale of Amenities

The following composition shall be adopted for residential units as per provisions of Requirements of low Income housing in NBC :2016 and guidelines of PMAY (Urban)

Overall planning at site should be done to maximize the density of housing with well organized green spaces and adequate width of roads for proper movements.

S. No	House Category	Living Room	Bed Room-one	Kitchen	Balcony	Toilets
1.	EWS	one	One	One	One	One (separate bath and WC)

2.1 Scale of Amenities (Minimum) :

Items No		Item	To be provided
1		Kitchen Cabinets	-
	i)	Cooking Platform with hole for cylinder pipe	Yes
	ii)	Stainless Steel AISI 304 (18/8) Kitchen sink as per IS 13983 with drain board	Yes
	iii)	Built in cupboard below cooking platform as per architectural design.	yes
2		Wardrobes	

	i)	Built in cupboard	In bed room up to ceiling height
3		Magic Eye (of SS grade 316) in front entry door	One
5		Set of Pegs SS grade 304	In toilet
6		18mm thick projected window Sill	Kota (If permitted as per the technology proposed)
7		WC with seats in toilets	
	i)	European-type floor mounted/wall-hung WC with seat, lid and low level flushing PVC cistern, water jet/health faucet. or Orissa pan WC with seat, lid and low level flushing PVC cistern.	In toilet, as approved
8		Wash Basin with CP Brass type Pillar Cock provided with quarter turns	One as per design, either outside of bath/toilet or inside bath
9		Tap (Kitchen, toilet,bath) CP Brass bib cock provided with quarter turns.	1 in Kitchen 1 in toilet 1 in Bath
10		Provision for shower	1 in Bath
11		Tower rail of SS grade 304	One in Bath
		Soap rack/Niche as per architectural Design and Specifications	1 in toilet
14		Plumbing for water purifier and Geyser.	Yes

2.2 Scale of Electrical Amenities (Minimum)

S. No	Description	Type / category of Accommodation
1	Power Points (15 amp 6 pins)	1 in each Room 1 in Kitchen 1 in Utility Area 1 in Bath Total 5
2	Plug Points	1 in each Room

	(5 amp)	1 in Kitchen 1 in Balcony 1 in Bath 1 in utility area 1 near washbasin Total 7
3	Provisions for Bracket Lights (with normal fittings excluding lamp/bulb)	1 in each Room 1 in Kitchen 1 in Toilet and Bath 1 in washbasin 1 in Balcony Total 7
4	Provision for Ceiling Fans	1 in each room Total 2
5	Call Bell Points	1 on Main Door
6	Provision for Exhaust Fans	1 in each Kitchen & Toilet
7	AC Points (with MCB connected socket outlet with wiring)	1 in each Room
8	Geyser Point (with MCB connected socket outlet with wiring)	1 in bath and kitchen (Geysers are not to be provided)
9	EDB/MCB Point (single phase)	1 at appropriate place
10	Cable TV Point	1 in each room
12	LED tube light fitting (excluding tube)	1 in each Room 1 in Kitchen Total 3
13	Modular Switches	Yes
14	Common areas of basement/stilt/residential towers	As per requirement of light intensity, fittings with lights (consumables) shall be fixed.

2.3 General Specifications

2.3.1 For Residential Units:

S.No.	DESCRIPTION	Residential houses
1.	Finishes	
	External Walls	It should be as per the requirement of proposed technology. However, External surface shall be made smooth with coarse putty before painting work
	Internal Walls & Ceiling	It should be as per the requirement of proposed technology. However, surface shall be made smooth with putty before painting work if required.
	Living Room	Low VOC Acrylic washable distemper
	All Bedrooms	Low VOC Acrylic washable distemper
	Kitchen	Low VOC Acrylic washable distemper
		Ceramic Tiles on all walls up to 6 feet height
	Toilets/ Bath	Ceramic tiles on all wallsupto 6 feet height.
	External Finishes	As per the architectural design
	Ceiling	Low VOC Acrylic washable distemper
2.	Flooring	
	Living room	Vitrified anti skid tiles (600mmx600mm) laid as per CPWD specifications.
	Bedroom	Vitrified anti skid tiles (600mmx600mm) laid as per CPWD specifications.
	kitchen	Vitrified tiles of (600mm x 600mm) laid as per CPWD specifications.
	Toilets/ Bath	Anti-skid ceramic tiles laid as per CPWD specifications.
	Balcony	Anti-skid ceramic tiles 300mm x 300mm laid as per CPWD specification.
	Common Circulation	Pre-Polished Kota Stone in single length of treads & riser

	Area	
	Staircase	Pre-Polished Kota Stone in single length of treads & riser
	Skirting / Dado / Wall Cladding	Skirting / Dado / Wall Cladding shall be matching with the floor with adhesive, as given below (i)100 mm high skirting matching the floor material (ii)Minimum 900 mm Dado in corridors / walkways
	Kitchen Platform	Pre-polished Granite Stone with nosing
3.	Door & Window Frames, Shutters and Hardware Fittings	
	Main Entrance Door Frame & Shutter	Frame of external door shall be made with pressed steel/ MS Angle iron (i)Outer Shutter shall be of MS with mosquito proof wire mesh with grill (ii)Inner shutter shall be 35mm thick factory made enamel painted.
	Door Frames	pressed steel/ MS Angle iron
	Window Frame	All frames of external windows must have double rebates for fixing same material frame with mosquito proof wire mesh
		UPVC extruded frame sections with wall thickness min. 2.0mm
	Door shutters	The door shutter shall be ISI marked flush door shutters conforming to IS 2202 (Part 1) Non decorative type,core of block board construction with frame of 1st class hard wood and well matched commercial 3 ply veneering with vertical grains or cross bands and face veneers on both faces of shutters .35 mm thick including ISI marked stainless Steel butt hinges with necessary screws with 25mm lipping
	Door Fittings	ISI marked Aluminium fittings e.g. Tower bolts, handles, door stopper etc. (IS:1378) Handles 150 mm -2, Tower bolt 12mm dia 300mm length -2, L drop- 300mm long & 16mm dia-1, Stopper-1, Buffer -1
	Toilets - shutters	24 mm thick factory made PVC door shutters made of styles and rails of an uPVC hollow section of size

		59x24 mm and wall thickness 2 mm (± 0.2 mm) with inbuilt edging on both sides. The styles and rails mitered and joint at the corners by means of M.S. galvanized /plastic brackets of size 75x220 mm having wall thickness 1.0 mm and stainless steel screws. The styles of the shutter reinforced by inserting galvanized M.S. tube of size 20x20 mm and 1 mm (± 0.1 mm) wall thickness. The lock rail made up of 'H' section, an uPVC hollow section of size 100x24 mm and 2 mm (± 0.2 mm) wall thickness, fixed to the shutter styles by means of plastic/galvanized M.S. 'U' cleats. The shutter frame filled with an uPVC multi-chambered single panel of size not less than 620 mm, having over all thickness of 20 mm and 1 mm (± 0.1 mm) wall thickness. The panels filled vertically and tie bar at two places by inserting horizontally 6 mm galvanized M.S. rod and fastened with nuts and washers, complete as per manufacturer's specification and direction of Competent Authority. (For W.C. and bathroom door shutter
	Kitchen doors	35mm thick shutter having 12mm thick pre-laminated particle board panel at the bottom part and MS wire mesh at upper part
	Window Shutter	Three track UPVC frame with double shutter one with glazed panel & other with wire mesh (of SS grade 304) shutter
	Fittings for Doors	Sliding door bolts, two tower bolts (250x10mm) and handles (125mm) of SS grade 304
	Fittings for Windows	Two tower bolts (150x10mm) and handles (100mm) of SS grade 304
4.	Water supply lines	
	External Pipeline up to 50mm	CPVC
	InternalPiping-Exposed on wall	CPVC
	Internal Piping – Concealed work	CPVC
	Soil & Waste Pipes and Fittings	UPVC
	Rainwater pipeand Fittings	Un-plasticised PVC rainwater pipe and un-plasticised PVC moulded fittings & accessories
5.	Water Proofing	

	Terrace of Top floor	As per technology proposed otherwise Koba treatment as per CPWD specification
	Sunken Area	As per technology proposed otherwise cement slurry
6.	Railing	
	Railing (balcony)	0.90mtr high M.S. railing in all the units in staircase of approved pattern with hand railing 40 mm MS (medium class pipe) Minimum weight 14 kg per meter and vertical bars of 12mm dia square bar at 100mm c/c embedded in waist slab.(as per Drawing) The height of railing shall be 0.90mtr from finished level of steps. (Drg. to be approved by Competent Authority).
	Railing (staircase)	same as above
7.	Miscellaneous	
	Plinth Protection:	50mm CC M -15 grade over 75mm bed of CC M -10 grade
	Numbering of houses:	The granite plate of 300 x 375 mm at height of 1200 mm from floor level at side of entrance door mentioning GHTC-India logo, beneficiary name, flat no., etc.
	Numbering at other places	The numbering of size 75mm in height shall be written with ISI marked enamel paint on overhead tanks,water meter box etc complete as per direction of Competent Authority

2.4 SPECIFICATIONS OF DEVELOPMENT WORKS: Specifications To Be Adopted for On-Site Infrastructure Work

ROADS

a. Internal Roads: The internal roads feeding the houses will be of 100 mm thick RCC of not less than M25 grade over a base course of PCC not less than M7.5 grade (100mm thick).

b. Peripheral Roads and pathways (as shown in drawing). "Providing and laying factory made chamfered edge Rubber Molded concrete coloredpaver blocks of required strength, thickness & size/shape, made by table vibratory method, to attain superior smooth finish using PU or equivalent moulds, laid in required mix of colour& pattern over 50mm thick compacted bed of coarse sand, compacting and proper embedding / laying of inter locking paver blocks into the sand bedding layer through vibratory compaction by using plate vibrator, filling the joints with fine sand and cutting of paver blocks as per required size and pattern, finishing and sweeping extra sand in footpath, parks, lawns, drive ways or light traffic parking etc. all complete as per manufacturer's specifications & direction of Competent Authority: 80 mm thick c.c. paver block of M-30 grade with approved color design".

The peripheral road, pathways and internal roads should be as per the CPWD specifications.

WATER SUPPLY

50 mm dia 6 kgf/cm^2 UPVC including all required fitting etc. as required including connection with existing line.

SEVERAGE SYSTEM

150mm dia. PVC pipe as per IS:14333 and IS:10910 of sq.cm with required Manholes etc. to be provided.

RAIN WATER HARVESTING TANK

Modular Rain Water Harvesting tank of required size will be constructed as per the CPWD specifications.

EXTERNAL ELECTRIFICATION WORK

Electric Panel: As necessary for the layout feeder Pillar Floor mounting totally enclosed compartmentalized cubical, dust vermin proof and outdoor type with required Earthing plate and bus bar complete including connections etc.

- Providing and Laying require Electrical cable for providing electrical supply to units, as approved.
- Providing and fixing street solar Lights as required including fixture and ESL, as per CPWD specifications.
- Making required connections to Building and flats.

- Providing and fixing solar light connection in stair case and common area.
- P/Laying XLPE insulated / P.V.C. sheathed cable of 1.1 KV grade with aluminum conductor Armored of IS:7098-I/1554-1 approved make in ground as per IS:1255 including excavation of 30cmx75cm size trench, 25 cm thick under layer of sand, 2nd class bricks covering, refilling earth, compaction of earth, making necessary connection, testing etc. as required of size.

  a. 35.0 Sq.mm 3.5 core
  b. 6.0 Sq.mm 2 core
  c. 4.0 Sq.mm 2 Core

BOUNDARY WALL with gates
The selected agency may like to use his proposed alternate technology for construction of boundary walls. Its height shall be minimum 2.1 mtr. high and 0.6 mtr. fencing with proper water proofing and drainage.

Or,
Brick / Block Masonry with R.C.C intermittent columns having grill of approved pattern and coping of CC 1:2:4 (1 cement: 2 Coarse sand: 4 graded stone aggregate) on top of wall with pointing as per approved drawing. Height of boundary wall shall be minimum 2.1 mtr. height solid wall and 0.6 mtr fencing above solid wall to make area secured.

EXTERNAL DEVELOPMENT WORKS

A. SPECIFICATIONS FOR WATER SUPPLY :

1. **Scope:** It includes excavation for pipes, laying of Ductile Iron pipes K-9 with necessary fittings, sluice valves, fire hydrants, air valves with necessary brick chambers, jointing of pipes and fittings, accessories, refilling of trenches and testing for leakage disinfection etc. complete to the satisfaction of Competent Authorityas per approved scheme in the specified boundary / area.

2. The water line system shall be laid as per the scheme approved by local authority. The sluice valves, fire-hydrants and air valves shall be IS marked. Any modification in this scheme approved by the Competent Authorityshall not violate terms of contract. The work shall be executed as per latest CPWD Specification with upto date correction slips and the relevant IS Codes shall be followed.

3. **Excavation:** The work includes excavation in all types of strata. For proper jointing of pipes and fittings the bottom of the trench and sides at the relevant places should be sufficient for doing proper lead caulking of joints. The top of the pipes would have at least cushion of 60 cm from the finished surface under road berms and 1.2 M under roads or as per direction of Competent Authority.

4. Ductile Iron pipes K-9 pipes duly approved by the Competent Authorityshall be used in the work. All collar jointed/flanged/ socketed fittings shall be of heavy class.

5. **Laying:** The Ductile Iron pipes K-9 shall be laid as per alignment shown in the approved drawings. In case it is considered necessary by the Competent Authority to alter the alignment as per site situations, so as to accommodate laying of other services viz.storm water drain, sewerage, horticulture pipes, and electric cables, no extra claims for the same would be entertained. While laying the pipes, it may be ensured that these water supply pipes have a horizontal and vertical separation of 3 meters and 0.5meter respectively from the sewer pipes. The water line should in no case run below sewer line.

6. **Jointing:** Water supply pipes, fittings and specials shall be jointed together with pig lead or flanged joints where necessary as per direction of Competent Authority. The pig lead brought at site shall be got tested from laboratory and only after the results are found to be satisfactory the same would be allowed to be used in the work and shall remain in joint custody. The day to day consumption of lead shall be maintained by the Junior Competent Authorityand the same would be signed by the agency as well. The quantity of lead to be used in joints of pipes, fittings and specials would be as per CPWD Specifications / IS Codes.

7. **Chambers:** Suitable fly ash brick chambers for housing the fire hydrants and sluice valves shall be constructed in brick masonry with bricks of class designation 75 in CM 1:5. The brick chambers shall have leveling course of CC 1:5:10, the chamber shall be plastered with CM 1:3, 12mm thick with a floating coat of neat cement. The chambers shall have RCC slab on top with required opening for operation of valves as per MS Specifications, indicating plate showing the positions of fire hydrants, and sluice valves also be provided.

8. Cement Concrete 1:2:4, thrusts blocks shall be provided as per CPWD Specifications for the various fittings/accessories.

9. **Disinfection/Testing:** After the work has been completed the lines shall be flushed with water containing bleaching powder @0.5gms/litre of water and cleaned with fresh water and the operation repeated 3 times till the sample of water is approved by Municipal Laboratory.

   Pipes laid shall be tested at twice the maximum allowable pressure to check water tightness of the joints and to detect any hair cracks in the pipes. After satisfactory completion of the work, 5 sets of completion plans, showing the alignment of lines, location of air valves, sluice valves, fire hydrants along with.

10. The work may be inspected by officials of local municipal/statutory authority or any other agency designated by MoHUA during execution.

11. UGR of required capacity with boosting arrangement in pump house i/c necessary installation for supply of water in the houses as per approval accorded. The design of UGR along with its capacity and pump house details such as power, motor details and others shall be as per the CPWD specifications.
12. The work shall be executed as per approval accorded by local authority and the design and drawings by Competent Authority, shall be final and binding on the agency and will not be open to questions.

B. SPECIFICATION FOR SEWERAGE:

The work shall be executed as per approval accorded by local authority and the design and drawings by Competent Authority, shall be final and binding on the agency and will not be open to questions. This work shall include excavation in all stratas, laying stone ware, RCC, NP2/NP3, S&S pipes, construction of manholes, providing SFRC manhole covers, frames, heavy duty, foot rests with necessary brick work in cement mortar, plaster, bed concrete and concrete up to haunches and around the pipes wherever required.

GENERAL:

1. Circular Manholes:
   a) Manholes shall be provided:
   (i) At starting point of each line,
   (ii) At all change points,
   (Gradient, size of the pipe, alignment)
   (iii) At all junction points of two or more lines. Manholes should be so spaced that each properly discharged in the direction of flow, and maximum centre to centre spacing of manholes will be as per prevailing Bye-laws.

2. Sizes of manholes:

S.No.	For depth of manhole between	Bottom diameter of manhole
1.	0.914 m to 1.68 m (3'-0" to 5'-6")	0.914 m (3'-0")
2.	1.68 m to 2.28 m (5'-6" to 7'-6")	1.220 m (4'-0")
3.	Beyond 2.28m (3'-0" to 5'-6")	1.520 m (5'-0")

   c) For depth less than 0.914 m, rectangular manholes of size 90x80 cm shall be provided.

3. The circular manholes shall be of minimum depth of 0.914m.

4. The depth of the manhole shall be taken as vertical distance between top level of SFRC cover and invert level of channel in the manhole. The work includes excavation in all types of soils for construction of manholes complete with orange colour safety foot rest of minimum 6mm thick plastic encapsulated as per IS:10910.

5. All manholes to be plastered both inside and outside with cement mortar 1:4 (1 cement: 4 coarse sand) with a floating coat of neat cement inside.

6. When sewer is being laid under sub-soil water 15cm thick stone soiling shall be provided under concrete bedding and 23cm thick under manholes.

7. Heavy duty SFRC manhole frames and covers 560mm internal dia. will be provided weighing 182 Kg. and to be tested as per IS:1726 (Part-I) for heavy duty loads. The covers shall be embossed with its year of manufacture and work 'SEWER' and IS Mark.

8. Drop Connection: Normally, no sewer line shall have a drop of more than 0.610 mtr. in any case. Wherever, the drop is more, a drop connection arrangement shall be provided as per sketch in CPWD Specification 1996, with amendments till date.

9. Pipes:Laying of sewerage lines shall include excavation in all types of soils, providing and laying of RCC, S&S pipes, NP2/NP3 as specified with rubber ring joints, testing and refilling etc., the completion of job to the satisfaction of Competent Authorityand according to the specifications prescribed.

(i) The S&S, RCC, NP-2/NP-3 pipes as per requirement / approved scheme IS marked will be used, with rubber ring and cement mortar joints.

(ii) Pipes laid at a depth less than 0.910m under road berms and green belts, and more than 4.57m shall be encased with 1:4:8 (1 cement : 4 fine sand : 8 graded stone agg. 40mm nominal size) cement concrete 15cm thick on all sides including under the pipes.

(iii) Extra excavation of at least 0.23m width in each side will be done for proper jointing of pipes at the location of sockets.

(iv) No sewer line shall be laid within a distance of 3.25m from building line - in case of roads. In case of service lanes / roads the sewer line shall be laid at centre of the lanes.

(v) The minimum size of pipe to be used shall be as per approved scheme.

(vi) In case the pipe are laid under sub-soil water level, the encasement shall be done with 1:3:6 (1 cement: 3 coarse sand: 6 graded stone agg. 40mm nominal size) instead of CC 1:4:8.

(vii) In other cases 0.15m bed encasement with 1:4:8 (1 cement : 4 fine sand : 8 graded stone agg. 40mm nominal size) cement concrete up to haunches of pipes shall be provided, the stone ballast shall be of 40mm nominal size for bed concrete and 20mm nominal size for around encasement of pipe. Where cushion is less than 0.90m around encasement of pipe with same mix will be done.

(i) Where the invert level of the manhole is 1.22m or more below the subsoil water level, 0.115m thick core of CC 1:2:4 (1 cement : 2 coarse sand : 4 graded stone ballast 20mm nominal size) shall be provided in the walls of the manhole upto 0.61m above sub-soil water level in order to prevent in-filtration of sub-soil water level, from the sides of the manhole shall be provided with 15cm thick 1:2:4 (1 cement : 2 coarse sand : 4 stone agg. 20mm nominal size) RCC slab, monolithically with the core of the wall of the manhole lean concrete of 1:5:10 (1 cement : 5 fine sand : 10 graded stone agg. 40mm nominal size) of 0.075m thick shall be provided under the slab.

10. Tests: The sewer line laid will be subject of following three tests:

a) Smoke Test:To check the air tightness of joints.
b) Mirror Test: To check the straight alignment of pipes.
c) Disc Test: To see that lines are free of dead/set concrete/ mortar/other blockages and lines laid are in straight line from manhole to manhole.

11. Any other tests, if required during course of execution will be decided by the Competent Authorityand will be binding on the agency.

NOTE: Nothing extra is to be paid to the agency for testing of pipes etc.

12. The agency will submit to Competent Authority adequate sets of completion plan of sewerage system laid showing position of manholes with its centre to centre distance dia. of lines, gradients, location of drop connections, connecting point with ground levels and invert levels at each point within 10 days of completion of the sewerage work. The service plan (in original) approved by the local body along with their forwarding letter be also submitted to the Competent Authority.

13. The following stops shall be maintained while laying the pipes:

S. No.	**Dia. of Pipe**	**Slope**
1.	250mm	1 in 190
2.	300mm	1 in 245
3.	350mm	1 in 300
4.	400mm	1 in 360
5.	450mm	1 in 510
6.	500mm	1 in 590

14. Crossing over nallahs shall be done by C.I. pipe with necessary support.

15. The conditions mentioned in the approved scheme of local authority shall be followed strictly.

C. SPECIFICATIONS FOR STORM WATER DRAINAGE:

C/o storm water drainage shall include excavating in all types of soils, providing and laying brick work with FPS bricks of CD-75 in CM 1:4 (1 cement : 4 coarse sand. Plastering of inside and top of both walls of drain shall be in CM 1:3 (1 cement : 3 fine sand) with floating coat of neat cement and outside plastering 6" in depth both side, CC 1:5:10 (with coarse sand) in bottom & CC 1:2:4 in channel of drain then covering of all drains with SFRC covers of design mix M-25.

Following specifications will be used for providing underground pipe drainage in the complex.

1. The work will be executed as per the design and layout approved by the local municipal authority.

2. FPS bricks of CD-75 shall be used.

3. Minimum width of the drains shall be 230mm or as per CPWD specifications.

4. SFRC covers of design mix M-25 shall be provided on all the drains.

5. Any other details, if required during course of execution will be decided by the Competent Authorityand will be binding on the agency.

D. SPECIFICATIONS FOR ROADS, PARKINGS & PATHWAYS:

1. Construction of internal approach roads and parking's will be done as per layout plan and standard laid down by local municipal authority. The agency will ensure that roads are developed to the dull right of way. The required metalled width will be provided to the exact crust thickness as per norms. The agency will ensure that nowhere the right of way of roads reduces. The roads will be laid to camber longitudinal as well as cross-section wise.

   The job of construction of roads consists of preparation of sub-grade, consolidation of the same, filling and compacting the earth work in embankment under optimum moisture conditions to give at least 95% of the maximum dry density (proctor density), supplying locally available stoneand screening of blue texture of the required laying of base and sub-base courses using binding and blinding material and necessary rolling as per specification, brick on edge and pre-mixing etc. The surface dressing of the berms of roads will be done in such a fashion so as to discharge the rain water of the open areas to the storm water pipe drainage. MORTH guidelines will be followed in case of any omissions.

2. Surface dressing of the berms with slope towards drainage system.

3. CC 1:2:4 (1 cement : 2 coarse sand : 4 graded stone agg. 20mm nominal size) pre-cast kerb stone fair face finish in uniform colour, of 0.30m long and 0.20m x 0.20m section as per CPWD Specifications / direction of Competent Authority jointed with the mix 1:2 (1 cement : 2 fine sand) to be provided as per architectural drawings.

4. Toe walls in brick masonry with bricks of class designation 75 in cement mix 1:4 for pavements/footpaths wherever necessary.

5. RCC NP2 S&S pipe joints in rubber rings and cement mortar 1:2 (1 cement : 2 fine sand) for cross drainage with gully chambers of size 50x45x60cms with M.S. grating of size 500x450mm wherever necessary as per decision of the Competent Authority.

6. Any other details that crop up depending upon site conditions will be decided by the Competent Authorityand will be binding on the agencies.

7. The specifications of CC pavement/footpath shall be as under:

   a) 100mm thick CC 1:5:10 (1 cement: 5 find sand: 10 graded stone agg. 40mm nominal size)

   b) 100mm thick CC 1:2:4 (1 cement: 2 coarse sand: 4 graded stone agg. 20mm nominal size) over under layer of CC 1:5:10 as per para 'a' above.

   c) Toe wall brick masonry with FPS bricks of class designation 75 in cement mortar 1:4 (1 cement: 4 coarse sand) to retain the edge of the paving.

8. The work will be done as per CPWD Specifications 2009 Vol. I &II with upto date corrections. Any other width of road as per approved development plan shall be as per prevailing norms.

9. The agency shall submit to the Competent Authority, adequate sets of completion plans for roads, paths after its completion showing right of way of each road/path and their respective cross section within 10 days of completion of road/path work.

SECTION-D

PAYMENT – SCHEDULE

1.0 All running /intermediate & final payments shall be made to the agency in accordance with the following schedule:

2.0 The basis of payment on "Pro rate basis" shall be worked out on the percentage of work done out of total scope of work

Sl. No	Activity	% payable
1.	Investigation, planning, Designing and obtaining approvals **(1% of total quoted rate)**	
1A	Submission of Inception Report, detailed survey, Architectural drawings ready for submission for approval of local bodies	
1B	On approval of local bodies, EIA clearances and other statutory approvals of local bodies, final Architectural drawing showing electrical and sanitary layout plan and drawings and its submission	
1C	On submission and approval of Vetted structural design by Competent Authority	
	On completion of above	1.0 %
2.	On completion of following:	
2A	Completion of excavation work, laying of foundation and reaching plinth level of all towers	10 %
2B	Completion of Super structure-Structural skeleton of external walls, slabs and other structural members, lift shaft and staircase well, etc. of residential and non-residential buildings/ towers	25.0%
2C	Internal work of residential and non-residential units with all Civil including flooring and skirting, dado-work, Electrical, Mechanical services, Plumbing	10.0%
2D	Finishing of Doors, Windows and wood work in wardrobes and complete kitchen work including all fittings and painting etc.	02.5 %
2E	Internal Finishing and painting inside residential and non-residential buildings	02.5 %
2F	External Finish and painting outside residential and non-residential buildings	02.5 %
2G	Over Head tanks, china-ware and sanitary fittings including testing etc.	02.5 %
2H	Electrical Installation including external electrification, installation of distribution boards, laying off cables, installation of electric sub-station and other associated electrical works etc.	02.5 %

	Installation of Lifts and machine room	02.5%
	Fire Fighting System	04.0%
	External Infrastructure outside residential buildings and within boundary wall including water supply, sewerage including STP/ septic tank, sewer line, inspection chambers, electricity lines, storm water drainage, rain water harvesting, solid waste management, signages, installation of solar street lights and other associated worksetc.	15.0%
	Site Development works including Horticulture Services, development of parks and green areas, Tot-lots, street furniture, construction of boundary wall and installation of gates, internal roads, Street lighting, other amenities etc.	10.0%
	On issuing of Completion Certificate by competent authority and after taking all statutory approvals from local authorities	10.0%

SECTION-E

PART -1

Financial Quote

SCHEDULE OF QUANTITIES
Name of Work:

S. No	Description of Item	Quantity (No. of Houses)	Units	Rate in Rs.		Amount Rs.
				In Figure	In Words	
1	**Construction of 1024 EWS units at LHP site at Indore, Madhya Pradesh including all associated facilities and services, development works complete as per scope of work, drawings attached with this document and directions of Competent Authority.**	A	L.S.	B		A x B
2	**Cost of Infrastructure Lumpsum for site specific as per RFP**		L.S.			
	Grand Total					

Note:

a) All participating agencies are advised to quote the rates in financial bids for both the items and L1 will be declared after getting the comprehensive rates for S.No. 1 and 2 otherwise, bids will be considered as non-responsive and will be rejected without assigning any reasons.

b) If any participating agency is quoting for more than one location with same or different technology, then the agency is required to quote separately for different locations as well as for different technologies.

c) Per unit rate of EWS house will be derived from lumpsum figure and calculations will be made for computation of total cost in case of number of EWS houses constructed get increase or decrease

SECTION-E

PART -2

Financial Quote

SCHEDULE OF QUANTITIES
Name of Work:

S. No	Description of Item	Quantity (No. of Houses)	Units	Rate in Rs.		Amount Rs.
				In Figure	In Words	
1	**Construction of 1144 EWS units at LHP site at Rajkot, Gujarat including all associated facilities and services, development works complete as per scope of work, drawings attached with this document and directions of Competent Authority.**	A	L.S.	B		A x B
2	**Cost of Infrastructure Lumpsum for site specific as per RFP**		L.S.			
	Grand Total					

Note:

a) All participating agencies are advised to quote the rates in financial bids for both the items and L1 will be declared after getting the comprehensive rates for S.No. 1 and 2 otherwise, bids will be considered as non-responsive and will be rejected without assigning any reasons.

b) If any participating agency is quoting for more than one location with same or different technology, then the agency is required to quote separately for different locations as well as for different technologies.

c) Per unit rate of EWS house will be derived from lumpsum figure and calculations will be made for computation of total cost in case of number of EWS houses constructed get increase or decrease

SECTION-E

PART -3

Financial Quote

SCHEDULE OF QUANTITIES
Name of Work:

S. No	Description of Item	Quantity (No. of Houses)	Units	Rate in Rs.		Amount Rs.
				In Figure	In Words	
1	**Construction of 1152 EWS units at LHP site at Chennai, Tamil Nadu including all associated facilities and services, development works complete as per scope of work, drawings attached with this document and directions of Competent Authority.**	A	L.S.	B		A x B
2	**Cost of Infrastructure Lumpsum for site specific as per RFP**		L.S.			
	Grand Total					

Note:

a) All participating agencies are advised to quote the rates in financial bids for both the items and L1 will be declared after getting the comprehensive rates for S.No. 1 and 2 otherwise, bids will be considered as non-responsive and will be rejected without assigning any reasons.

b) If any participating agency is quoting for more than one location with same or different technology, then the agency is required to quote separately for different locations as well as for different technologies.

c) Per unit rate of EWS house will be derived from lumpsum figure and calculations will be made for computation of total cost in case of number of EWS houses constructed get increase or decrease

SECTION-E

PART -4

Financial Quote

SCHEDULE OF QUANTITIES
Name of Work:

S. No	Description of Item	Quantity (No. of Houses)	Units	Rate in Rs.		Amount Rs.
				In Figure	In Words	
1	**Construction of 1008 EWS units at LHP site at Ranchi, Jharkhand including all associated facilities and services, development works complete as per scope of work, drawings attached with this document and directions of Competent Authority.**	A	L.S.	B		A x B
2	**Cost of Infrastructure Lumpsum for site specific as per RFP**		L.S.			
	Grand Total					

Note:

a) All participating agencies are advised to quote the rates in financial bids for both the items and L1 will be declared after getting the comprehensive rates for S.No. 1 and 2 otherwise, bids will be considered as non-responsive and will be rejected without assigning any reasons.

b) If any participating agency is quoting for more than one location with same or different technology, then the agency is required to quote separately for different locations as well as for different technologies.

c) Per unit rate of EWS house will be derived from lumpsum figure and calculations will be made for computation of total cost in case of number of EWS houses constructed get increase or decrease

SECTION-E

PART -5

Financial Quote

SCHEDULE OF QUANTITIES
Name of Work:

S. No	Description of Item	Quantity (No. of Houses)	Units	Rate in Rs.		Amount Rs.
				In Figure	In Words	
1	**Construction of 1000 EWS units at LHP site at Tripura, Agartala including all associated facilities and services, development works complete as per scope of work, drawings attached with this document and directions of Competent Authority.**	A	L.S.	B		A x B
2	**Cost of Infrastructure Lumpsum for site specific as per RFP**		L.S.			
	Grand Total					

Note:

a) All participating agencies are advised to quote the rates in financial bids for both the items and L1 will be declared after getting the comprehensive rates for S.No. 1 and 2 otherwise, bids will be considered as non-responsive and will be rejected without assigning any reasons.

b) If any participating agency is quoting for more than one location with same or different technology, then the agency is required to quote separately for different locations as well as for different technologies.

c) Per unit rate of EWS house will be derived from lumpsum figure and calculations will be made for computation of total cost in case of number of EWS houses constructed get increase or decrease

SECTION-E

PART -6

Financial Quote

SCHEDULE OF QUANTITIES
Name of Work:

S. No	Description of Item	Quantity (No. of Houses)	Units	Rate in Rs.		Amount Rs.
				In Figure	In Words	
1	**Construction of 1040 EWS units at LHP site at Lucknow, Uttar Pradesh including all associated facilities and services, development works complete as per scope of work, drawings attached with this document and directions of Competent Authority.**	A	L.S.	B		A x B
2	**Cost of Infrastructure Lumpsum for site specific as per RFP**		L.S.			
	Grand Total					

Note:

a) All participating agencies are advised to quote the rates in financial bids for both the items and L1 will be declared after getting the comprehensive rates for S.No. 1 and 2 otherwise, bids will be considered as non-responsive and will be rejected without assigning any reasons.

b) If any participating agency is quoting for more than one location with same or different technology, then the agency is required to quote separately for different locations as well as for different technologies.

c) Per unit rate of EWS house will be derived from lumpsum figure and calculations will be made for computation of total cost in case of number of EWS houses constructed get increase or decrease

SECTION-F

DETAILED TECHNICAL SPECIFICATIONS OF SHORTLISTED PROVEN TECHNOLOGIES

2.1 Precast Concrete Construction System - 3D Precast Volumetric

(1. M/s Katerra India Private Limited, 2. M/s Moducast Pvt. Ltd., 3. M/s Magicrete Building Solutions, 4. M/s Ultratech Cement Ltd.)

1. Manufacturing of 3D Volumetric Components

   Fabrication and manufacturing of solid precast concrete modules (room, toilet ,kitchen, bathroom, stairs etc) through 3D volumetric casting or structural modules cast in Plant/Casting yard assembled together through casting of wall and floor panels. Modules shall be manufactured in controlled factory environment with approved methodology including moulds, mixing, transporting and placing of concrete, vibrating, curing, finishing, making necessary cutout/holes of required sizes for services, yard handling & stacking all complete as per approved shop drawings and design mix as per the direction of Engineer-in-Charge.

2. Transportation of Modules

   Transportation of Precast Elements by flat bed Trailor (Double / Triple axle 40ft Length with proper accessories like A frame etc) from factory, including loading, unloading & stacking at site with the help of required capacity cranes.

3. Erection & Installation of Modules

   Erection & Installation of Precast Concrete modules in correct & final position with proper line level and plumb at site making all arrangements (i.e cranes, push-pull jacks & all another T & P for lifting Placing & Alignment of elements, within erection tolerance as per IS 15916 (Building Design and Erection Using Prefabricated Concrete - Code of Practice) shall be as per approved shop drawings and all complete as per the direction of Engineer-in-Charge including all accessories, jointing, grouting complete. The structure shall be complete in all respect with all internal and external finishing as per approved drawings.

All relevant Indian Standards/ requirement of NBC shall be conformed for designing, casting , prefabrication ,erection and installation.

2.2. Pre-cast Concrete construction System –Pre-Cast components assembled at Site

(1. M/s Larsen & Toubro, 2. M/s B.G. Shirke Construction Technology Pvt. Ltd., 3. M/s Elematic India , 4. M/s PG Setty Construction Technology Pvt. Ltd. 5. M/s Teemage Builders Pvt. Ltd. 6. M/s Nordicflex House 7. M/s Adlakha Associates Pvt. Ltd. 8. M/s William Ling)

1. Manufacturing of Solid Pre-cast concrete Elements

Solid precast concrete elements shall be fabricated and manufactured with provisions of shear keys, connecting loops, dowel tubes and proper lifting accessories for walls, beams, slabs, stairs, column etc, of various thickness, shape and size of different concrete grades manufactured in controlled factory environment with approved methodology including moulds (Pallet system, Tilts form, table moulds, battery moulds, vertical moulds, beam moulds, column moulds, staircase moulds, Facade mould, etc.), mixing, transporting and placing of concrete, vibrating, curing, finishing, making necessary cutout/holes of required sizes for services, yard handling & stacking all complete as per IS 11447:1985 (Code of practice for construction with large panel prefabricates) and as per approved shop drawings and design mix as per the direction of Engineer-in-Charge. Minimum grade of Concrete for solid structural components shall be M-35.

2. Manufacturing of Pre-stressed Hollow core Slab

Pre-stressed Hollow Core slab (Hollow area 25 to 30%) of different thickness & modular width 1200 mm shall be fabricated & manufactured in controlled Factory Environment with approved methodology by using long line casting method having arrangement of proper steel bed. Concreting should be done by batch mixing plant capable of producing zero slump concrete, transported through automatic shuttles of standard make & layed on bed with the help of extruder/Slip former, finishing, curing and also provision of steam curing. Cutting, making necessary cutout/holes of required sizes for services in slab element after achieving required strength, yard handling & stacking all complete as per approved shop drawings & design mix as per the direction of the Engineer-in-charge. Minimum grade of Concrete for pre-stressed hollow slab is to be M-40.

Pre-stressing steel strands (low relaxation) shall be provided & laid in position on hollow core bed by using mechanical pulling arrangement like Rabbit/ Bed master including all accessories for Stressing & de-stressing operations as per approved make conforming to IS1343 (Pre-stressed Concrete — Code of Practice) & grade FY-1860 etc, complete as per drawings and direction of Engineer -in-charge.
All relevant Indian Standards/ requirement of NBC shall be confirmed.

3. Transportation of Pre-cast elements

Transportation of Precast Elements by flat bed Trailer (Double / Triple axle 40ft Length with proper accessories like A frame etc) from factory, including loading, unloading & stacking at site with the help of required capacity cranes.

4. Erection & Installation of Pre-cast elements

Precast/Pre-stressed Concrete elements shall be erected & Installed in correct & final position with proper line level and plumb at site making all arrangements

(i.e cranes, push-pull jacks & all another T & P for lifting placing & alignment of elements, within erection tolerance as per IS 15916 as per approved shop drawings and all complete as per the direction of Engineer-in-Charge

Weather proof sealant shall be applied on outer joints of approved make confirming to relevant Indian Standard.

Leveling sim pads of required sizes (5x5cm to 10x10cm) of PVC / Rubber to adjust level of bearing surface of supporting members shall be applied.

Grouting of dowel tubes / Shear keys / Joints of precast members with M-60 grade cementations grout (Non Shrink) of approved make by suitable means (Free flowing /pump) shall be done including curing etc.

2.3 Light Gauge Steel Structural System & Pre Engineered Steel Structural System

2.3.1 Light Gauge Steel Structural System

(1. M/s Mitsumi Housing Pvt. Ltd., 2. M/s Everest Industries Ltd., 3. M/s JSW Steel Ltd., 4. Society for Development of Composites, 5. Elemente Designer Home 6. M/s MGI Infra Pvt. Ltd., 7. M/s RCM Prefab Pvt. Ltd., 8. M/s Nipani Infra and Industries Pvt. Ltd., 9. M/s Strawture Eco, 10. M/s Visakha Industries Ltd.)

1. Fabrication & Installation of LGSF Framing Components

Designing, providing, installing and fixing factory finished custom designed cold form Light Gauge Steel Framed super structure comprising of steel wall panel, trusses, purlins etc manufactured out of minimum 0.75 mm thick steel sheet as per design requirements. The steel sheet shall be galvanized (AZ-150 gms Aluminum Zinc Alloy coated steel having yield strength 300- 550 Mpa) conforming to AISI specifications and IBC 2009 for cold formed steel framing and construction and also as per IS: 875- 1987 (Part-I; Dead Load , Part-II; Imposed load, Part-III; wind load , Part-IV; Snow load, and Part-V; Special load & load combinations), IS 800-1984 (Code of practice for general construction in steel) and IS: 801- 1975 (Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members In General Building Construction). The wind load shall be as per provisions of IS 875 (part -III). LGSFS frame shall be designed as per IS: 801 using commercially available software such as Frame CAD Pro-11.7/ STAAD PRO-V8i/ArchitekV2.5.16/ Revit architecture2011 or equivalent.

The framing section shall be cold form C-type having minimum web depth 89 mm x 39mm flange x 11mm lip in required length as per structural design requirement duly punched with dimple/slot at required locations as per approved drawings. The slots will be along centre line of webs and shall be spaced minimum 250mm away from both ends of the member. The frame can be supplied in panelized or knock down condition in specific dimensions and fastened with screws extending through the steel beyond by minimum of three exposed threads. All self drilling tapping

screws for joining the members shall have a Type II coating in accordance with ASTM B633(13) or equivalent corrosion protection of gauge 10 & 12, TPI 16 & 8 of length 20mm. The frames shall be fixed to RCC slab or Tie beam over Neoprene rubber using self expanding carbon steel anchor bolt of dia as per approved drawings, design subject to minimum 12mm diameter and 121mm length conforming to AISI 304 and 316 at 500mm c/c with minimum embedment of 100mm in RCC and located not more than 300mm from corners or termination of bottom tracks complete in all respects.

Hot rolled Steel sections as per design & conforming to IS 800 can be used for buildings higher than G+3.

2. Connections

Proper usage of Connection Accessories like Heavy duty tension Ties, Light duty Hold-ons, Twist Straps (to connect truss with wall frames), Strong Tie, Tie Rod, H-Brackets, Boxing Sections, L-Shaped Angles shall be ensured for required structural integrity & stability.

3. Walling Components

Walling with Fiber Cement board & Gypsum plaster board

Providing and fixing of external wall system on Light gauge steel frame work with outer face having 6mm thick heavy duty fiber cement board fixed on 9mm thick heavy duty fiber cement board confirming to IS 14862:2000, category IV type A (High pressure steam cured)as per standard sizes fixed with self-drilling / taping screws / fasteners@ 60cm c/c of approved make. A grove of 2 mm to 3mm shall be maintained and groves shall be sealed with silicon based sealant.

The board shall be fixed in a staggered pattern. Screws shall be of ounter sunk rib head of 1.60mm to 4 mm thick of 8 to 10 gauge of length varying from 25 to 45 mm and internal face 12.5mm thick gypsum plaster board fixed on 8mm thick fiber cement board confirming to IS 14862:2000 of category III type B (High pressure steam cured) as per standard sizes fixed with self-drilling / taping screws / fasteners @ 60cm c/c of approved make, proper taping and jointing to be done using fiber mesh tape and epoxy and acrylic based jointing compound for seamless finish.

A breathable vapour barrier underneath the cement fiber board as per National Building Code2009 is to be provided complete as per direction of Engineer-in-charge.

Any other suitable in-fill walling materials can be used in the system, however it shall be such that the completed wall provides fire resistant & other properties as per the requirements given in National Building Code 2016.

4. Floor/ Slab

RCC floor/ roof slab as per design conforming IS 456 over deck sheet shall be provided. The thickness and profile of decking sheet shall be verified with the erection drawings. These are normally used as temporary supports for the concrete till hardens. Decking sheet has to be screwed to the joist with maximum spacing of 600 mm c/c for uniform action of concrete and joist. All the joints of decking sheets longitudinal direction require a minimum lap of 100 mm.

2.3.2 Pre-Engineered Steel Structural System (PEB)
(1. M/s RCC Infra Ventures Ltd.)

Pre-engineered Building (PEB) shall be of structural steel construction with columns, rafters, beams etc. as per design & conforming to and walls shall be of Autoclaved Aerated Concrete (AAC) blocks of approved composition, size and strength. Building shall be designed, manufactured, supplied and erected by the agency. The structural design shall be done as per the prevailing Indian standards and conforming to NBC 2016. Floor/roof slab shall be of RCC as per approved structural design. The structure will be complete in all respect with all plumbing, sanitary, electrical installations, painting and finishing as per approved drawings.

2.3.3. Pre-Engineered Steel Structural System (PEB) with speed floor system (1. M/s Jindal Steel & Power Ltd.)

Pre-engineered Building (PEB) shall be of structural steel construction with columns, rafters, beams etc. and walls shall be of Autoclaved Aerated Concrete (AAC) blocks of approved composition, size and strength. Building shall be designed, manufactured, supplied and erected by the agency. The structural design shall be done as per the prevailing Indian standards and conforming to NBC 2016. Floor/roof slab shall be of Speed Floor system which is a suspended concrete flooring system using a roll formed steel joist as an integral part of the final concrete and steel composite floor as per approved structural design. The Speed floor system is a hybrid concrete/steel tee-beam in one direction and an integrated continuous one-way slab in other direction. The joists of different depths are manufactured from pre- galvanized high tensile steel. The joist depth and the concrete thickness are varied depending on the span, imposed loads and other functional considerations. The structure will be complete in all respect with all plumbing, sanitary, electrical installations, painting and finishing as per approved drawings.

2.3.4 Aerated Cement Concrete Panel System with Steel Structural Framing System
(1. M/s HIL Ltd.,
(2. M/s Biltech Building Elements Ltd.,.
(3. M/s SCG International India Pvt. Ltd.)

1. Manufacturing & Fixing of Aerated Concrete Panel

Providing and fixing in position factory made non asbestos fibre reinforced aerated cement sandwich wall/roof/floor light weight solid core panels made of light weight cement concrete core composed of OPC cement, pulverized fly-ash, quick lime, cotton pulp & Gypsum in mortar state mixed with aeration agent in a preset mould. The outer face on both sides of the panels shall be non asbestos fiber cement board conforming to IS 14862:2000. These solid wall panels shall be installed using Galvanized iron steel tracks/C channel of 1mm thick of required sizes as recommended by manufacturer's and fixed to floor and RCC/ steel soffit in plumb to each other with steel screw/fasteners. The panel shall be fixed vertically with tongue & groove joint with cement based polymer modified jointing compound. The exposed surface finished with fiber mesh/glass fiber tape with polymer based jointing compound having superior flexibility. Panels should be used as floor & roofing with additional structural support, steel or RCC depending upon the design. All the operation shall be completed in all respect as per drawings, Manufacturers specifications and under the overall direction of Engineer-in-Charge

2. Steel Structural Framing System

Steel structure frame as per design & conforming to IS: 800 shall be used in the construction. Steel tracks/ C channels as per manufacturer's specification should be used to hold the panels with the structure firmly. All jointing need to ensure required structural stability & integrity.

All relevant Indian Standards/ requirements of NBC shall be conformed.

2.3.5 Pre-Cast Light Weight Hollow core wall panel (1. M/s Pioneer Precast Solutions Pvt. Ltd.)

1. Manufacture of Hollow Core Panel
   Construction using "Hollow Core light weight concrete non-load bearing wall panels manufactured in controlled factory conditions using battery moulds, light weight concrete (density 675 to 750 kg/m^3) and other additives as per manufacturer's specification. Panels are pre-cured naturally for 12-24 hrs and then water cured for seven days before installation. Panels are provided with tongue and groove joints for easy assembly. Panels are Battery mould panels. Panels are produced in standard widths & thickness and in lengths suitable to room height. Standard width is 611 mm, height 2900 and thickness 65 mm, 80 & 100mm. Panels shall conform to tolerances w.r.t. Length : + 3mm, Width : + 2mm, Thickness : + 1mm, Squareness of end : +3mm.The structure will be complete in all respect with all plumbing, sanitary, electrical installations, painting and finishing as per approved drawings.

2. Structure Framing Section & Connection

Being non-load bearing, these panels are used with structural steel frame designed as per relevant Indian Standards and conforming to NBC 2016. The connection to framing section shall ensure required structural integrity & stability.

3. Floor/ Roof slab
   RCC floor/ roof slab as per design conforming IS 456 over deck sheet shall be provided. The thickness and profile of decking sheet shall be verified with the erection drawings. Decking sheet has to be screwed to the joist with maximum spacing of 600 mm c/c for uniform action of concrete and joist. All the joints of decking sheets longitudinal direction require a minimum lap of 100 mm.

   All relevant Indian Standards/ requirement of NBC shall be conformed.

2.4 Prefabricated Sandwich Panel System

2.4.1 Reinforced Expanded Polystyrene Core Panel System (1. M/s Worldhaus, 2. M/s Bau Panel Systems India Pvt Ltd, 3. M/s BK Chemtech Engineering, 4. M/s MSN Construction, 5. M/s Beardshell Ltd.)

The technical specifications would be entirely based on design parameters, however, the minimum specification as given below is recommended to be adhered to;

1. Specifications of Raw Materials for EPS Panel

   i) Zinc Coated cold drawn Steel Wire – Shall be of 2.5/3.0 mm dia and zinc coating galvanizing shall be of 60 gm/m2 ± 5 gm/m2

      Mechanical characteristics
      Yield stress : > 600 N/mm2
      Breaking load : > 680 N/mm2
      Elongation : > 8%

      Chemical characteristics
      % C : < 0.24
      % P : < 0.055
      % S : < 0.055
      % Ceq : < 0.52

   ii) Expanded Polystyrene – Self-extinguishing type EPS 80 in accordance to UNI EN 13163:2013 (IS 4671: 1984) having density not less than 15 kg/m3

2. EPS Panels for wall

Walling shall be completed using factory made Expanded Polystyrene Core Panel (EPS) based electro welded wire mesh 3D panels manufactured using the specified EPS and Cold drawn wire and sprayed structural plaster. The specification of panel shall not be less than the values given in **fig. 1 & 2**below. Both the outer faces of the panel shall be finished by applying the layer of minimum 35 mm thick cement mortar 1:3 {1 cement: 3 coarse sand (not having more than 40% stone chips of size upto 6 mm)} with the help of shotcreting / guniting equipment etc at a pressure not less than 1 bar (100Kn/m2) and both surfaces finished with trowel. The composition of spray/ mortar shall be such as to give minimum characteristic strength of 25 N/mm^2. The maximum w/c ratio shall be 0.45. The thickness of the sprayed concrete & EPS wall shall be based on design requirements.

Single panel for structural uses

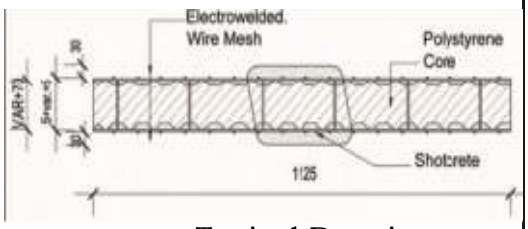
Longitudinal wire	Min 2.5 mm ø spaced @ 70 mm (Max.)	 Typical Drawing
Transverse wire	Min 2.5 mm ø spaced @ 70 mm (Max.)	
Cross steel wire	Min 3.0 mm ø approx 68 nos. / m^2	
polystyrene Core	Density >15 Kg/m^3, Thickness not less than 80 mm	
Finished Masonry	Not less than 150 mm thick	
Grade of Shotcrete	Minimum M-25	

Fig.1

Single panel for internal partition andinsulation

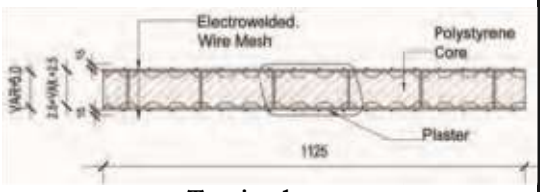
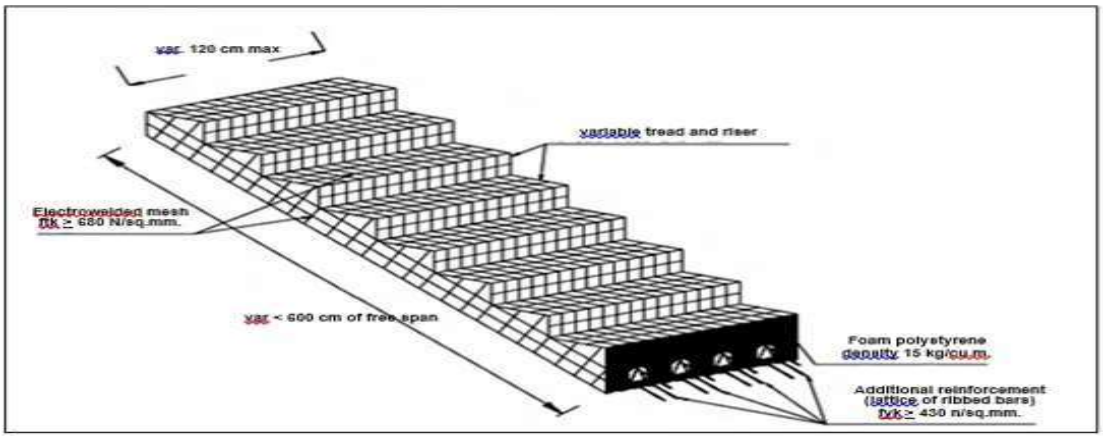
Longitudinal wire	Min 2.5 mm spaced @ 8 mm (Max.)	 Typical Drawing
Transverse wire	Min 2.5 mm spaced @ 7 mm (Max.)	
Cross steel wire	3.0 mm approx 45 nos / m^2	
polystyrene Core	Density > 1 Kg/m^3, Thickness 4 mm to 320 mm	
Finished Masonry	Min 90 mm	

Fig2

3. Staircase panel

The EPS panel based staircase would be preferred as per minimum specification given in **Fig.3**. However, the Agency can propose for construction of staircase in RCC or steel frame based staircase for approach on all floors up to terrace floor. The concrete thickness shall be as per as per design requirement &spary/mortar shall be minimum 30 mm.



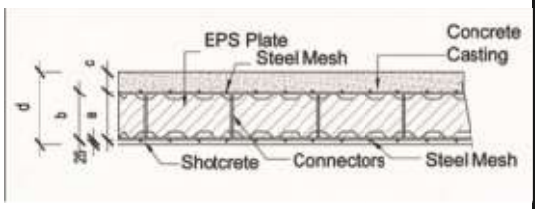
Galvanized steel wire mesh:

Longitudinal wires:	2.5 mm dia
Transversal wires:	2.5 mm dia
Cross steel wire:	3.0 mm dia
Polystyrene slab density:	> 15 kg/m³

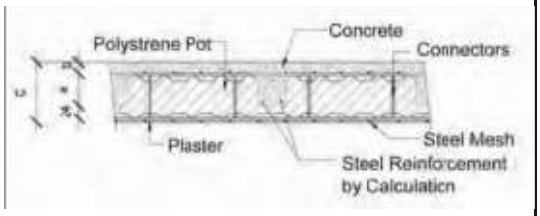
Fig 3

4. Flooring & Roofing
   Intermediate floor shall be composite EPS as per specification and shall be designed for combined effect of dead load, imposed load & other loading conditions. The specification of panel shall not be less than the values given in **fig. 4** below

Single Panel for horizontal structure for floor/ roof

Longitudinal wire	Min 2.5 mm ø spaced @ 80 mm	
Transverse wire	Min 2.5 mm ø spaced @ 75 mm	
Cross steel wire	Min 3.0 mm ø approx 68 nos. / m^2	
polystyrene Core	Density Min15 Kg/m^3 Thickness Min 80 mm	
Finished Masonry	Min 160 mm thick	
Grade of Shotcrete/ concrete	Min M-25	

Floor panel with reinforcement at joist

Longitudinal wire	Min 2.5 mm ø spaced @ 80 mm	
Transverse wire	Min 2.5 mm spaced @ 70 mm	
Cross steel wire	Min 3.0 mm ø approx. 68 nos. /m^2	
polystyrene Core	Density > 15 kg/m^3	

a = thickness of core; b = thickness of concrete; c = overall thickness

The Panels to be used for the floor and the roof system and reinforced in the joists with concrete casting on the site. The reinforcement of the panel can be integrated during the panel assembly by additional reinforcing bars inside the joists as per the design.

Fig.4

5. **Connections;**

Jointing of the panels shall be ensured in such a way to make it safe from vertical load, lateral loads and impact loads & to provide required structural integrity & stability. Jointing shall be sealed properly.

2.4.2 EPS Cement Sandwich Panel System

(1. M/s Bhargav Infrastructure Pvt.Ltd, 2. M/s Rising Japan Infra Private Limited)

1. **Manufacturing & Fixing of EPS (Beads) based Cement Panel**

Providing and fixing in position factory made EPS cement sandwich wall/roof/floorlight weight solid core panels made of core material of EPS granule balls/beads(conforming to IS 4671:1984 and shall have density not less than 15kg per cum)adhesive, cement, sand, flyash and other bonding material in mortar state processedto form in a preset mould. The outer face on both sides of the panels shall be nonasbestos fiber cement board conforming to IS 14862:2000 or Calcium silicate board conforming to EN 14306:2009 of 5mm thick each. Panel shall be laid on 6mm thick cement mortar (1 cement: 2 fine sand) mixed with chemical adhesive of 0.5kg per50kg of cement or shall be preferably fixed into 'C' channel made of 1.2mm thick MS plate screwed/ fastenened to the slab/column/beam etc. The panel shall fixed vertically with tongue and groove joint and horizontally locked with steel bar between each other and floors and filled with cement mortar and adhesive. Panels should be used as floor & roofing with additional structural support, steel or RCC depending upon the design. All the operation shall be completed in all respect as per drawings, manufacturers specifications and under the overall direction of Engineer-in-Charge

2. **Steel Structural System**

Steel structure frame as per design & conforming to IS: 800 shall be used in the construction. U type channels as per manufacturer's specification should be used to hold the panels with the structure. Additional clips may be welded with the frame pillars and beams to hold

the U channel firmly with the pillars/beans and floor, to ensure structural integrity. PU glue may be applied to hold the panels firmly.

All relevant Indian Standards/ requirements of NBC shall be conformed for materials, design ,fabrication and erection.

2.4.3 Pre-fab PIR (Polyisocyanurate) based Dry Wall Panel System (1. M/s Covestro India Pvt. Ltd.)

1. PIR Dry Wall Pre-Fab Panel raw material & Structural System
   Construction with PIR Dry Wall Pre-Fab Panel non-load bearing walling system where two fiber cement boards (FCB) of 10 mm thickness shall be filled with insulation foam material namely Poly Isocyanurate (PIR) in-situ and erected to produce straight to finish walls.
   Fiber Cement Board: Shall be 100% asbestos free and of Type A, Category 3 minimum. as stipulated in IS 14862:2000.(ii) Pre-painted Galvanized Iron (PPGI) sheet: Shall be 0.5mm thick and as conform to IS 14246:2013 (iii) Square Hollow Section (SHS)/C Channel: Shall be manufactured from pre-galvanized high tensile steel conforming to IS 277:2003. (iv) Fibre glass mesh: Shall be as per manufacturer specifications. (v) Acrylic based glue: Shall be as per manufacturer specifications. (vi) Galvanized MS screws: Shall be as per manufacturer specifications. (vii) Anchor fasteners: Shall be of 10mm to 12mm dia., 50mm to 75mm length and as per manufacturer specifications. (viii) Premix Putty: Shall conform to IS 419:1967.
   PIR wall being non-load bearing wall panels shall be supported with Steel Structural frame members as per approved structural design & conforming to IS 800 (Code of practice for general construction in steel).

2. Erection & Installation of Components

   Erection & Installation of Steel sections in correct & final position with proper line level and plumb at site making all arrangements (i.e cranes, push-pull jacks & all another T & P for lifting Placing & Alignment of elements, as per approved shop drawings and all complete as per the direction of Engineer-in-Charge including all accessories, jointing, grouting complete. The structure shall be complete in all respect with all internal and external finishing as per approved drawings.

3. Floor/Roof

In-situ RCC slab or RCC slab over deck sheet as per design & relevant code shall be provided as per approved drawing.

2.4.4 Load Bearing Insulated Sandwich Panel System for Walling & Flooring (1. M/s Project Etopia Group)

Brief of Housing System

It is proprietary 4Wall panelised construction system comprising of light weight load bearing insulated panels. The System is sustainable since the panels can be deconstructed & recycled. The system is energy positive (uses solar grids) with no carbon produced from running/operation of the building & it creates more energy than used, feeding back to main building. The system introduces daylight mimicry, creates perfect lighting environment irrespective of rain & shine condition. It has air purification system & smart control.

Specifications of the panel;

S. No.	Key Aspects of the system/panel	Values/details
1.	Strength	Structural loading strength of 825 KN/80 tonne
2.	Thermal Value	0.13 U value with light weight panel structure
3.	Structural Fire Resistance	66 minutes (40KN)
4.	Air Tightness	0.07 l/s/m2
5.	Panel Lightness	Heaviest panel weighs 97 Kg, meaning it can easily be lifted and transported
6.	Hurricane Resistance	Can handle/withstand winds exceeding 400 Mph

Structural Requirement

The structural design calculations should clearly demonstrate structural integrity and stability including connection details. In addition, any other requirements including safety against earthquake need to be ensured by the designer as per prevailing codal requirements. All relevant Indian Standards/ requirement of NBC shall be conformed.

2.5 Monolithic Concrete Construction System

(1. M/s Maini Scaffold Systems Pvt. Ltd., 2. M/s KumkangKind India Pvt. Ltd, 3. M/s S-form India Pvt. Ltd., 4. M/s ATS Infrastructure Ltd., 5. M/s Innovative housing & Infrastructure Pvt. Ltd 6. M/s MFS formwork Systems Pvt. Ltd., 7. M/s Knest Manufacturers LLP. 8. M/s Outinord Formworks Pvt. Ltd. 9. M/s Brilliant Etoile)

Aluminum Formwork System

The customized Aluminum formwork using grade 5052 aluminum with panel sheets of minimum 4 mm thick shall be used for monolithic construction of RCC members & for extruded sections grade 6061 (Type-6) aluminum shall be used. The panel sheets shall have repetitive usage of 100 times. The form work includes of beam components i.e. beam side panel, prop head for soffit beam, beams soffit panel, beam soffit bulk head and deck components i.e. deck panel,

deck prop, prop length, deck mid, soffit length, deck beam bar and wall components i.e. wall panel, rocker, kiker and internal soffit corner, external soffit corner, external corner, internal corner etc., The panels are to be held in position by pin and wedge system that passes through holes in the out side rib of each panel. The tolerance of finished panels to be (-1 mm), and shall conform to IS 14687-1999 (False work for concrete structures – Guidelines). Pins and wedges to be made of high grade mild steel.

Modular Tunnel Form Work System

The Modular Tunnel form System shall consist of inverted L- shaped half tunnels (one vertical panel and one horizontal panel) joined together to create a tunnel. These forms are to be made up of factory cut, 80mm x 80 mm angle sections in accordance with the line of building forms. The panels shall be designed based on loading requirements with minimum 3 mm hot dip galvanized steel sheet, stiffened by folded sheet metal sections. All components shall meet relevant Indian Standards.

Structural Design

The structural design of plain & RCC shall be as per IS 456:2000 while IS 13920:2016 (Ductile detailing of reinforced concrete structures subjected to seismic forces -Code of practice) is referred for ductile detailing of reinforced concrete structure. Thickness of wall below plinth level should be minimum 200 mm with double layers reinforcement. The minimum thickness of RCC wall member shall be 120 mm. All relevant Indian Standards/ requirement of NBC shall be conformed.

2.6 Stay In Place Formwork System

2.6.1 Expanded-Steel Panel reinforced with all Galvanized Steel Wire-Struts (M/s JK Structures)

Expanded-Steel Panel reinforced with all-galvanised Steel Wire-Struts serving both as the load-bearing steel structure and as the stay-in-place steel formwork filled with EPS-alleviated concrete.

Construction of monolithic structure completely “on site”, without formwork with 3D galvanized structural steel (as per manufacturer specification) panels assembled and reinforced with interlocked 3D steel studs and then injected with pumped-in and hand-finished EPS (expanded polystyrene) -alleviated concrete (as per approved mix design and manufacturer’s specification) combining in one single process a stay in place formwork with embedded columns and beams and bracing system. The EPS alleviated concrete is concrete produced with EPS beads. Erection &installation of the structure in correct & final position with proper line level and plumb at site making all necessary accessories &arrangements. per approved drawings and all complete as per the direction of Engineer-in-Charge including all accessories, jointing, grouting complete. The structure shall be complete in all respect with all internal and external finishing as per approved drawings. All relevant Indian Standards/ requirement of NBC shall be conformed

2.6.2 GFRG Panel Building System (M/s FACT RCF Building Products Limited)

1. Providing & Erecting GFRG Panels

   Standard quality GFRG panel of 124 mm thickness with modular cavities procured from GFRG panel manufacturing plant in the country, cut to required wall sizes and floor/ roof slab sizes in correct length and height, including cutting of door, window and ventilator opening as per the cutting drawing prepared by architects /design engineers for the construction of GFRG building and loaded in still ages for transportation to the construction site. Panels to be unloading at site using suitable fork lift/ crane.

   Erection of GFRG Panels in walls in all floors using suitable crane as per instructions of Engineer-in-Charge, as per cutting drawings and structural drawings, in perfect line and plumb, above RCC plinth beam/GFRG panel below and provide necessary lateral/ slanting support to keep the wall panel in safe position, providing &tieing of Reinforcement as per structural drawings and applying a coat of water repellant coating Zycosil/equivalent or equivalent product (1 Zycosil/equivalent compound: 10 water) to saturation level over RCC plinth beam to provide water proofing treatment to joint between wall panel & plinth beam to make it sealed completely.

   Note:

   i. When cutting panel, "A" side is to be for outside or external surface of respective external wall and B side is to be for internal surface of wall
   ii. Erection of panel is to be with reference to both building plan & cutting drawing by following notational mark indicated in the cutting drawing as well as notional mark written on each panel cut as per cutting drawing

2. Filling of empty cavities

   Filling of empty cavities (as shown in the structural design drawing) with quarry dust mixed with 5% cement (by volume). After initial infill of 50 mm thick with M25 concrete at base/bottom of cavities to seal off, infill wall panel cavities in 3 stages as detailed below,

   i. 1st pour / infill to be limited to 0.3 to 0.50 m height from bottom of the panel.

   ii. 2nd Pour/ infill: infilling shall be done only after 90 minutes interval between successive pours. The maximum height of infill shall be restricted to 1.5m height or up to the top level of door / window.

iii. 3rd pour/infill: After an interval of 90 minutes of second pour, infill or pour the balance height up to the bottom of embedded RCC tie beam. Pour enough water just required to dampen the dry mix enough to form cake form after each stage. (If any rain falls in between any stages of concrete pour, make sure to cover the panel top to prevent ingress of water or water falling into the cavities. In case of water collection over the concrete inside the panel, drill 10mm hole in GFRG panel immediately above concrete filled level to drain out water before pour/in-fill of balance concreting)

3. Laying of GFRG panel as roof / floor slab panel and staircase panel

Laying of GFRG panel as roof / floor slab panel and staircase panel using suitable crane as per instructions of Engineer-in-Charge, including providing support system with 25mm x 300mm-400 mm wide plywood, as runner with proper prop below proposed micro beams including

a. Cutting of top flange of panel to 180 mm wide (leaving 25mm projection on either side) to provide RCC embedded micro beam as per cutting drawings and structural drawings.

b. Reinforcement for micro beams and tie beams to be provided in position with proper anchorage as per structural drawings.

c. Provision for Electrical cabling, fan hooks and laying of pipes for plumbing work.

d. Concreting of Tie beam, micro beam and top of GFRG panels (50 mm thick) with M-25 cement concrete mix using coarse aggregate of size less than 20 mm including laying of 10 gauge 100mmx100mm size weld mesh with 25 mm effective cover from the panel top.

Supplying and fixing 10 Gauge weld mesh of size 100mm x100 mm for floor/roof slab concrete screed over the micro beams as reinforcement. The weld mesh shall be fixed as per drawing.

4. Waterproofing Applications & Sealing of Joints

i. Application of ZMB 60/equivalent solution (100 Kg ZMB 60/equivalent, 1 litre ZMB Nano Thinner, 20 litre water & 1 LitreZycoprime/equivalent = 122 litre/kg) over already applied coat of Zycosil/equivalent & Zycoprime/ equivalent solution on the top of all the RCC plinth beams by brush/spray coat before erection of GFRG over RCC plinth beams in GF. In the case of upper floors 150 mm wide on floor slab for all the external walls, bath/toilet/ wet areas (3 hrs drying time) before erection of wall panel on upper floors including erection of parapet wall.

ii. After erection of GFRG wall panels, seal all GFRG wall joints with paper tape temporarily. Water proofing treatment of vertical joints with

Zycosil/equivalent water proofing Solution (1 litre of Zycosil/equivalent & 20 litres of water stirred first & 2 litres of Zycoprime/equivalent added and stirred (total 23 litres)) with 50 ml syringe till the gap and in filled concrete is completely saturated. After removing the paper seal, seal off the vertical joints with water proofing material "Grout RW/equivalent".

iii. Filling of joints between RCC plinth beam / floor slab and wall panel of external walls, toilet / bath room / wet areas walls on all floor and parapet wall over roof slab, stair case head room at the time of erection of GFRG panels with Grout RW/equivalent sealant compound after the erection of panel before the infill of concrete in panel cavities and fine finish. This applies for all horizontal and vertical joints between GFRG wall and slab panels.

iv. Water proofing treatment of Vertical joints (of external side and internal side) between door frame, window & ventilator frames (on all four sides) of outer wall over the Zycosil/equivalent &Zycoprime/equivalent solution already applied (before the installation of door / window / ventilator frames in position) and fine finish with Grout RW/equivalent.

v. Water proofing treatment of RCC sunshade with Zycosil/ equivalent water proofing Solution (1 litre of Zycosil/ equivalent & 20 litres of water stirred first & 2 litres of Zycoprime/equivalent added and stirred (total 23 litres)) till it meets the saturation level and testing as per RILEM or by water drops test in which water drops do not absorb but drops remain or rolls.

vi. In-filling / sealing of joint between RCC lintel cum sunshade and wall (on external side) in all floors by pushing in Grout RW/equivalent in paste form and coving 20 mm x 20 mm after applying a coat of Zycosil/equivalent &zycoprime/equivalent solution before cement plastering of top, bottom and sides of RCC sunshade.

All relevant Indian Standards/ requirement of NBC shall be conformed.

2.6.3 Structural Stay In Place Galvanized Steel formwork system (M/s Coffor Construction Technology Pvt. Ltd)

Brief Discription

The form work system comprises of two filtering grids made of rib mesh reinforced by 'C' channel vertical stiffeners.

The grids are connected by rebar which act as horizontal stiffeners and connect or which act as a shear link. The grids on both faces act as sacrificial formwork in which concrete is poured in-situ.The vertical steel channels and horizontal steel bars act as steel reinforcement for load bearing wall. The connectors help to fold the formwork for easy transportation.

After the erection of formwork panels in alignment, corners, edges of doors and windows frame are closed with rebar positioning & concrete of required grade is poured in the panels. The concreting may be done with a pump,

bucket or with a shovel loader. The inside and outside walls are finished with cement plaster of suitable grade.





The panels are prefabricated according to a structural plan (based on client's architectural plans) designed by structural engineers.

Product assembly Components in Structural Stay-in-Place Formwork Panel:

The various parts of Structural Stay-in-Place Formwork panel are explained briefly below:

C-Chanel

These are vertical stiffeners, work as vertical steel in Reinforced Concrete wall

It is made up of 0.6mm thick galvanized sheet. The 180GSM to 275GSM zinc coating is used based on geological location to prevent rusting of steel.

Area of profile is 60.6 mm^2(i.e> 8 mm dia bar)

Placed at every 200 mm distance along the width

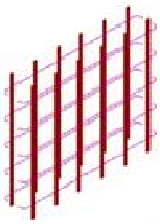


Rebar

Rebar's are horizontal stiffenersatevery200mmor100mmcentreto centre

It is 5 mm dia MS bars and work as distribution bar.

Made up of Fe 415 Grade steel



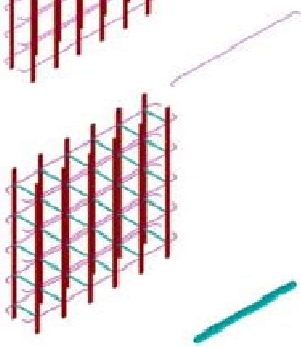
Connector

Connects C profile & Rebar.

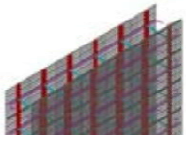
It is made up of 1.6 thick Cold Rolled Cold Annealed (CRCA)platesof120 gm/m^2 zinc coated sheet to prevent rusting

Works as shear link to connect steel on both face of form work.

Also helps to avoid bulging of formwork during concrete pouring.



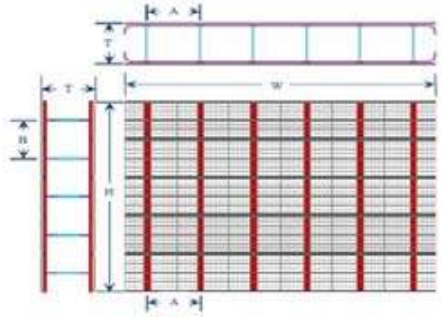
Part – 4: Rib Mesh



Rib meshes are filtering grids.
Theyaremadeupof0.42mmthickhighgalvanizedsheetwith180 GSMto275GSM zinc coating used as per geologic allocation to prevent rusting of steel. It works as reinforcement to plaster to prevent crack generated due to contraction and expansion. Also provide good bonding to plaster

Size and Types of Panels

Panels are normally produced in sizes as given below (See Fig. 2): Width (W): 300mm, 500mm, 700mm, 900mm &1100mm Height (H): 500mm to 5000mm in multiples of 100 mm. Thickness (T): 100mm, 140mm, 160mm, 200mm & 250mm. However, customized sizes also be made available on demand.



Panel Type	T mm	A mm	B mm	W mm	H mm
C10	100	200	100, 200	300,	Min.
C14	140	200	100, 200	500,	500
C16	160	200	100, 200	700,	then
C20	200	200	100, 200	900,	in multiples
C25	250	200	100, 200	1100	of 100

Fig.2

Types of panels are given below:

i. Standardsinglepanels–
Thesepanelsshallbeusedforslabshutteringbutmayalsobeusedasshuttering option for RCC wall having thickness of more than 350mm. (Fig. 3)

ii. Doublepanels–
Doublepanelsshallhaveinbuiltsteelandnotrequireextrareinforcement.Indo ublepanels, the grids shall be connected by articulated rebar loops and connectors that fold.

These panels are of two types:

a. Standard double panels shall be of fixed size and need to be cut on site for openings etc.
b. Customizeddoublepanelsfromthefactoryshallhaverequiredcuttingforop eningsasperdrawing and there is no need for cutting on site.
c. These panels create a monolithic structure as it allows pouring of walls and slab together. These panels shall be used for load bearing walls, retaining walls and shear walls. (Fig. 4)

iii. Insulated Double panel– These panels shall have an integrated insulation on the exterior side. The insulated material shall be of polystyrene or polyurethane of required thickness as per design.(Fig. 5)

iv. Fiber Cement Double panel–These panels shall have its interior face as fibre cement board which has smooth surface and avoid plastering of walls. (Fig.6).These panels may be used for water retaining structures.



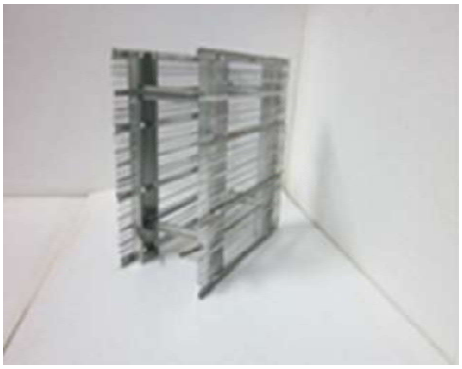


Fig.3 Standard Single Panel Fig.4 Standard Double Pane



Fig.5 Insulated Panel



Fig.6 Fiber Cement Panel

Foundation

Strip Footing or normal column and beam structure up to Plinth level based on soil condition.

In case of Strip footing, Coffor panels will start from foundation and on the top of strip concrete raft which increase speed to come out from the ground.

Installation of Panel:

Layout and Blocking

The alignment shall be traced with chalk on the two sides. Boards/batten shall be nailed on the ground to indicate the positioning of one face of the panels.

Positioning the Panel

- The Structural formwork panels shall be fitted over projecting vertical reinforcing rods. Each panel shall be held vertically with wood pieces (boards/battens) or metal pieces (L-sections/tubes). The minimum length of these bracing elements shall not be less than 1.80m. The panels shall preferably be positioned beginning from the angles and from the doors. Whenever length of the wall does not correspond to a multiple of width of the panels, the last panel shall be cut with a rotary saw to adjust to length

of the wall. The horizontal battens shall be installed on a single side. The verticality shall be checked using a plumb line or level.

- Shuttering of Slab: after completion of Coffor panel installation of the wall, slab shuttering will start either with use of Coffor single panels or normal conventional shuttering for RCC or any other slab.

- Plumbing and Electrification: After installation of slab shuttering, electrical and plumbing conduits can be placed in between panels. For installing the electrical box, panels can be cut with small grinder machine.

- Panel alignment & slab steel needs to be checked & ensured prior to concreting.

- Concrete Pouring: The placing of concrete of specified grade is done in wall and slab in one go with either with Boom placer, stationary pump or manually. As all concreting is done in one go, a monolithic reinforced concrete structure is created.

Structural Requirements of the Construction

Design analysis of the Structural formwork walls, panels, floor slabs etc. shall be done using Staad Pro Software or equivalent. The Optimal result is obtained when walls shall be designed as braced construction elements whose horizontal loads are supported by other bracing elements belonging to the same construction e.g. shear walls. The panels with concrete shall act as "lightly reinforced RCC walls" as per clause 32 of IS 456:2000 and as "prefabricated concrete load bearing walls" as per IS 15916:2010 & IS 15917:2010 & amp; IS 15971:2010.

Structural design and analysis of the formwork shall be based on relevant Indian and International standards. The panel construction assembly shall be used for free standing walls when designed and anchored as cantilever walls. Panels shall be reinforced and tied at vertical joints to maintain alignment. Additional reinforcement and cement plaster shall be provided as per the design requirement. Foundation shall be specifically designed in accordance with provisions given in IS 1904:2005. All relevant Indian Standards/ requirement of NBC shall be conformed.

2.6.4 Stay-in-Place Formwork System PVC Form for Shear Walls (M/s Joseph Jebastin (Novel Assembler Private Limited)

Brief Description

Stay in place PVC form wall System consists of rigid poly-vinyl chloride (PVC) based polymer components that serve as a permanent stay-in-place durable finished form-work for concrete walls. The extruded components slide and interlock together to create continuous formwork with the two faces of the wall connected together by continuous web members forming hollow rectangular components. The web members are punched with oval-shaped cores to allow easy flow of the poured concrete between the components. The hollow Wall

components are erected and filled with concrete, in situ, to provide a monolithic concrete wall with enhanced curing capacity due to water entrapment, as the polymer encasement does not allow the concrete to dry prematurely with only the top surface of the wall being exposed to potential drying. The polymer encasement provides crack control vertically and horizontally for the concrete, and provides vertical tension reinforcement thus increasing the structural strength of the wall. Steel dowels are necessary to anchor the wall to the concrete foundation.

Size of Panels

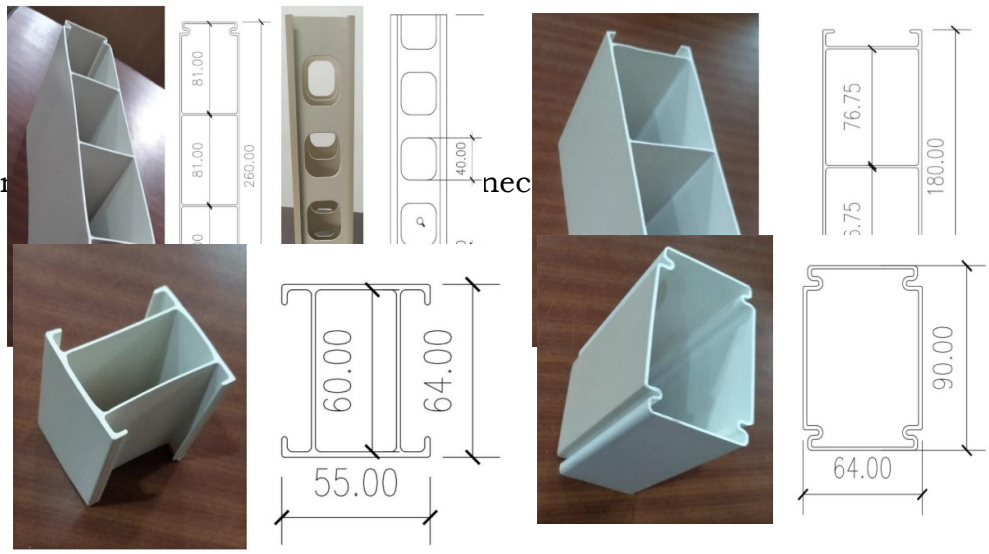
Size: Wall Panels have been developed in various cross-sectional sizes as per project requirement. The common sizes are 64mm, 126mm, 166mm & 206mm. However available wall types are as follow:

Wall components	**Wall Thickness**		
	Overall (Nominal)	**Concrete Core**	**Insulation[1]**
N64	64 mm	60 mm	0
N126	126 mm	120 mm	0

- N64 walls are erected individually and not preassembled, except for headers and sills.
- Pre-assembled walls sections are used for walls over 4300 mm (14') high
- The height of walls made with the Formwork vary according to the requirement.
- N126 walls less than 4300 mm (14') high are erected individually except for walls of unique projects and for headers and sills.

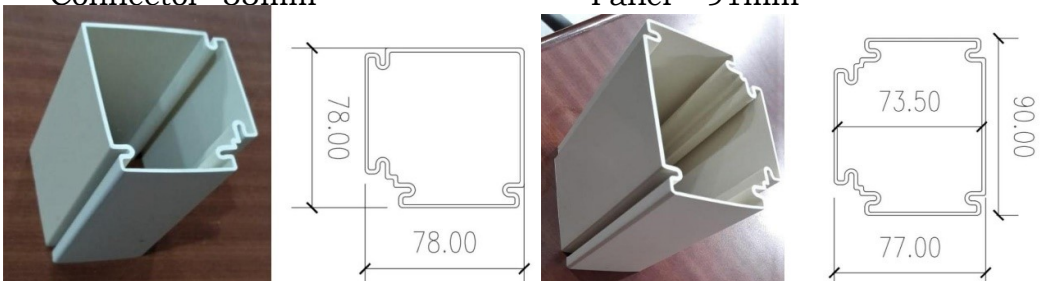
Panel Components

Main Pa nec



Connector -33mm

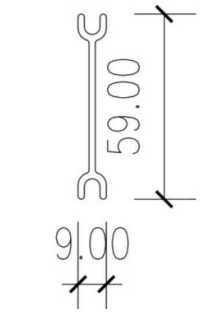
Panel – 91mm

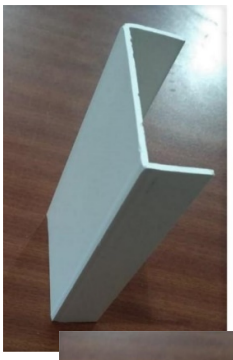


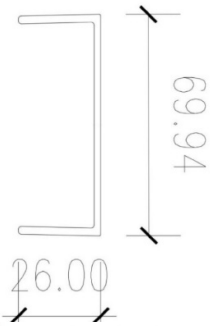
Corner Panel 3-WAY (T-CONNECTOR

Jointer C

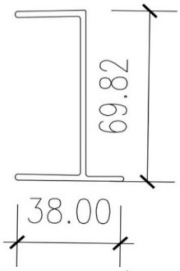




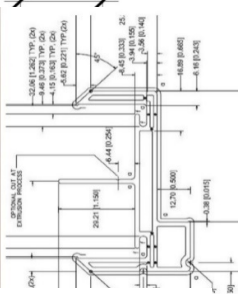






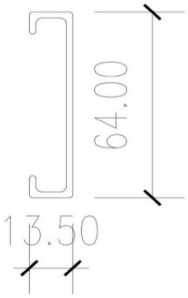




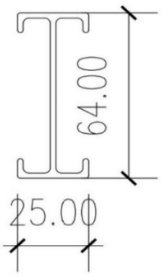


Starter









Design Consideration

General

The walls shall be designed to accommodate a wide range of axial, wind and seismic load conditions, using the equations developed for conventional and slender concrete walls. However, one of the unique properties of Novel walls is the ability of the permanent polymer formwork to provide concrete confinement and reinforce the concrete in tension. There are two main structural elements used in the wall, namely panel sections and box connectors. The panels come as three-cell sections 250 mm wide, while the box connectors are one-cell sections 64 mm wide. The webs of these elements have oval cores which allow lateral flow of the poured concrete between the adjacent cells and provide a mechanical transfer of forces between the concrete and the polymer thus creating a composite action.

Floor/Slab

In-situ RCC slab as per IS:456:2000 shall be provided.

Structural Aspects

The buildings constructed with the system walls shall be designed as reinforced concrete structure since the parameters required for their design are the same as needed for traditional reinforced concrete. The building shall be designed in accordance with IS 456:2000, as applicable.

The system shall be designed to provide the required performance against the loads to be taken into account in accordance with IS 875 (Parts 1-5):1987 and the data given by manufacturer for various panels. It shall also provide the required bearing resistance for earthquake and wind forces as per IS 875 (Part 3):2015 and IS 1893 (Part 1):216, wherever applicable.

Foundation shall be specifically designed in accordance with provision given in IS 1904:2005. Both single and double panels should have starter bars from either foundation or ground floor slab.

The structural design calculations should clearly demonstrate structural integrity and stability including connection details. In addition, any other requirement regarding safety against earthquake need to be ensured by the designer as per prevailing codal requirements. All relevant Indian Standards/ requirement of NBC shall be conformed.

2.6.5 Insulating Concrete Forms (ICF) System (M/s Reliable Insupack Building Solutions)

Insulating concrete Forms (ICF) System comprises of a panel of two walls of *Expandable Polystyrene* (EPS) separated by a nominal distance of 150mm by hard plastic ties. These are assembled on site to hold reinforced concrete. The forms are open ended hollow polystyrene blocks which fit tightly together to form a shuttering system. Concrete poured into the hollow space to form a continuous wall. When cured, this wall supports the structural loads from floors and roofs, and the shuttering provides thermal insulation. Reinforcing steel shall be as required as per the design parameters. Upper and lower surfaces of the polystyrene panels are castellated and the vertical mating surfaces are tongue-and-groove to form a tight fit when joined together. The rigid formwork does not require supporting falsework. Form locks are used for end stops. The outer surfaces are grooved vertically at 50 mm centres to aid cutting and trimming. Plan view of ICF is shown in Fig. 1.

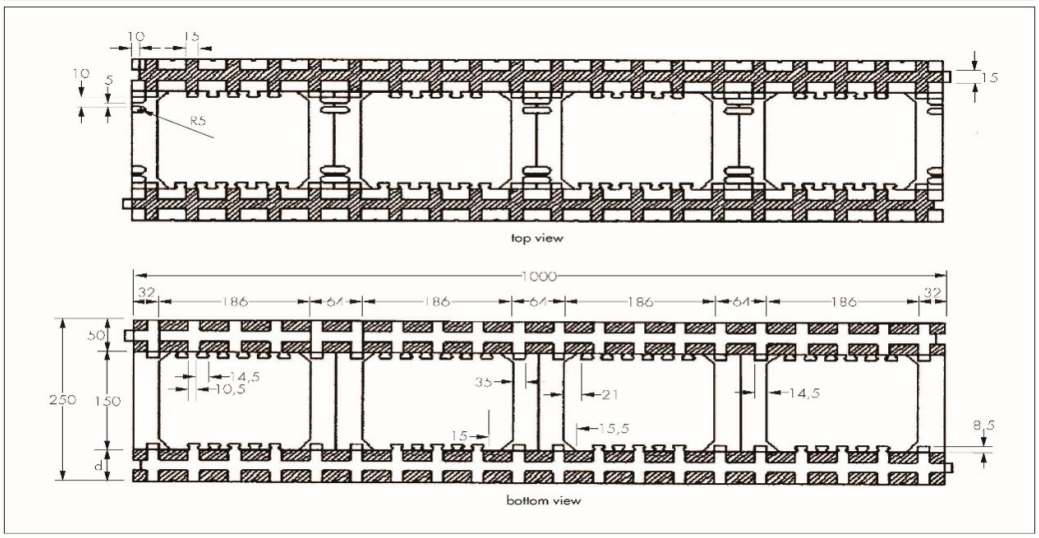


Fig. 1

Types of Forms

Standard Forms – These form bulk of the forms and have 50mm EPS panels on both sides with hard plastic ties holding the panels. Dimensions of these forms are 1000 x 250 x 250mm. (See Fig. 2)

Lintel Forms -In combination with Half Height forms, these form the top layer of all wall gaps and hold the concrete thus preventing thermal leaks. Dimensions of these forms are 1000 x 125 x 250mm. (See Fig. 3)

Half Height Forms **–**Together with the lintel, these form the top layer of all gaps in the wall and hold the required steel reinforcement. Dimensions of these forms are 1000 x 150 x 250mm. (See Fig. 4)

Floor Edge Forms – These form the top most layer, where the wall ends and floor begins. This envelopes the floor slab and thus prevents thermal bridging. Dimensions of these forms are 1000 x 375/125 x 250mm. (See Fig. 5)

Corner Forms –These constitute 90° corner of the building.The two sides are 50mm EPS panels held together with 8 hard ties. Dimensions of these forms are 750/500 x 250 x 250mm. (See Fig. 6)

End Forms –These create wall ending by fitting in inside the Standard or Corner form and provide a smooth and thermal bridge ending to the wall. Dimensions of these forms are 150 x 125 x 50mm. (See Fig. 7)

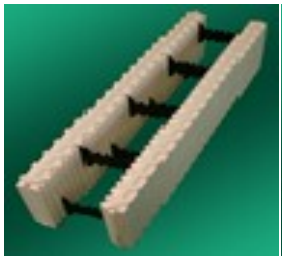


Fig. 2 Standard



Fig. 3 Lintel

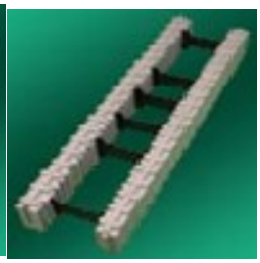


Fig. 4 Half Height

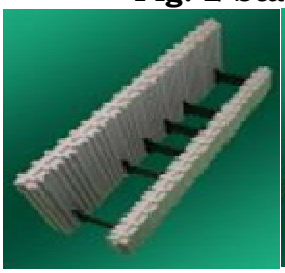


Fig. 5 Floor Edge

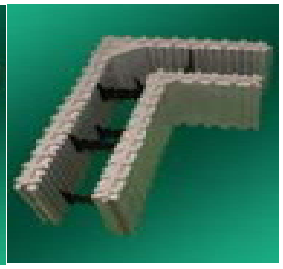


Fig. 6 Corner



Fig. 7 End

Typical construction

Construction process

The construction of most Insulating Concrete Forms (ICF) & Monolithic Insulated Concrete Systems (MICS) buildings is fundamentally a process of stacking lightweight blocks to gether in a similar manner to building bricks, laying reinforcement where necessary and pouring concrete into the voids of the block work.

Footings

The footings for Insulating Concrete Forms (ICF) & Monolithic Insulated Concrete Systems (MICS) buildings shall be reinforced concrete rafts or strips that are flat and even enough to enable stacking of the form blocks, with reinforcement starter bars set ready to connect with the concrete when poured into the formwork.

Load bearing walls

Any Insulated Concrete System/Forms wall can be designed to be load bearing.

Joints and connections

Joints and connections with other building elements shall be kept to a minimum, especially when the flooring or roofing elements are also made from Insulated Concrete System/Forms.

Fixings

The foam block work or form work forms a poor basis for any fixings. Light loads are generally carried by the lining or facing materials, such as plaster board, and heavier loads can be carried by supporting points drilled in to the concrete that forms the inner material of the Insulated Concrete System/Forms.

Openings

Major openings for doors, windows, etc., shall be set out in the form work as it is relatively difficult to make changes later, owing to the fundamentally monolithic nature of the structural elements. Once openings have been made, they can accommodate window and door frames of any type. A typical kind of fixing uses timber blocks set in to the ends of the form blocks around the opening. Electrical conduit and plumbing is generally run in chasing in the depth of the form blocks.

Finishes

Finishes are dependent on the materials used to face the Insulated Concrete System/Forms units. Typically, the main finish is a render or render-equivalent covering or paint. Any additional cladding can be added to the Insulating Concrete Forms (ICF) & Monolithic Insulated Concrete Systems (MICS) walls subject to making appropriate sup- ports for it, although many sheet finishes, such as plaster board, can be glued directly to the surface of the formwork. External renders require a base or skim coat embedded with fiber glass mesh, followed by a second coat and then a texture coating, finally finished with an 'armor coat'.

RAW MATERIALS

- Expanded Polystyrene (EPS): Self-extinguishing type EPS shall conform to IS 4671: 1984 having density not less than 25 kg/m3 and valid Restriction of Hazardous Substance (ROHS) test certification.
- Polyurethane (PU) Foam Adhesive: Shall have Skin Formation of 8 min, Density 25 kg/m^3, Sound insulation 58 dB, Insulation factor 35 mW/mK, Shrinkage< 2%, Fire rating B3, Insulation factor 35 mW/m.K and Water absorption of 1 % volume
- Plasticizer: Slump retaining super plasticizer for self-compacting plastic concrete (CEMWET SP-3000) shall conform to IS 9103:1999
- Hard Plastic Tie: Shall be made with High density polyethylene ensuring stability
- Cast-in-place concrete: The ingredients, grade of concrete & slump for walls, floors and roofs shall be used as per IS 456:2000.

Structural Aspects

The Insulating Concrete Forms (ICF) & Monolithic Insulated Concrete Systems (MICS) may be designed using the appropriate design software. The buildings constructed with EPS shall be designed as reinforced concrete structure since the parameters required for their design are the same as needed for traditional reinforced concrete. In the calculation model, the building shall be designed in accordance with IS 456:2000, as applicable, as structure composed of load bearing walls with a box-like structure.

The system shall be designed to provide the required performance against the loads to be taken into account in accordance with IS 875 (Parts 1,2,4&5):1987. It shall also provide the required bearing resistance for earthquake and wind forces as per IS 875 (Part 3):2015 and IS 1893(Part1):2016, wherever applicable. All relevant Indian Standards/ requirement of NBC shall be conformed.

2.6.6 Building PVC wall material
(M/s Kalzen Realty Pvt. Ltd)

Brief Description

Stay-in-place formwork consisting of hollow□type rib- reinforced Poly-vinyl chloride (PVC) material comprising of two PVC panel facings with internal PVC ribs, are used as permanent formwork for concrete walls. The web members are punched with cores to allow easy flow of the poured concrete between the components. After putting vertical & horizontal reinforcement as per the design, the hollow Wall components are filled with concrete, in situ, to provide a monolithic concrete wall.

Standard Panels

The standard size of available panels is as follows;

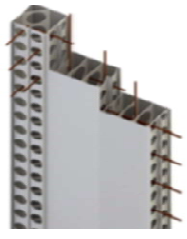
Height	Standard panels: 3 meters or 3.3 meters heights All panels can be ordered to custom height Minimum 0.5m; Maximum 6m
Panel width	Standard wall panels: 400mm Half wall panels: 200mm Quarter panels: 100mm
Thicknesses of Profile	110, 150 and 200 mm
PVC thickness	2.5 mm
PVC density	1,300 kg/m^3
Concrete volume	110mm profile: 0.10 cum per sqm 150mm profile: 0.14 cum per sqm 200mm profile: 0.18 cum per sqm
Weight	110mm profile: 18.1 kgs per sqm 150mm profile: 21.6 kgs per sqm 200mm profile: 23 kgs per sqm

The product shall not be affected by exposure to sunlight either in storage or as part of finished product.

Walling System

The wall shall be erected by placing the panels side by side or sliding the new panel down from top and held by using the clipping mechanism. The panel shall have double-hole system ensuring the position of the horizontal and vertical steel reinforcing bars.

The horizontal bars shall be placed along with the laying of panel and vertical bars shall be placed by dropping from top to improve the accuracy and structure of the wall, and minimize variations in the



concrete thickness surrounding the reinforcing bars. Once the wall is erected, the plumbing and electrical conducting is done as per the design. After this, concrete of required Garde as per structural design shall be poured into the cavities. Once filled, the system acts as structural element. The external surface shall have specified finish.

Floor/Slab

In-situ RCC slab as per IS:456:2000 shall be provided.

Structural Aspects

The buildings constructed with the system shall be designed as reinforced concrete structure since the parameters required for their design are the same as needed for traditional reinforced concrete. The building shall be designed in accordance with IS 456:2000, as applicable.

The system shall be designed to provide the required performance against the loads to be taken into account in accordance with IS 875 (Parts 1-5):1987 and the data given by manufacturer for various panels. It shall also provide the required bearing resistance for wind forces &earthquake as per IS 875 (Part 3):2015 and IS 1893 (Part 1):2016, wherever applicable.

Foundation shall be specifically designed in accordance with provision given in IS 1904:2005. Both single and double panels shall have starter bars from either foundation or ground floor slab.

The structural design calculations should clearly demonstrate structural integrity and stability including connection details. In addition, any other requirements including safety against earthquake, cyclone shall be ensured by the designer as per prevailing codal requirements. All relevant Indian Standards/ requirement of NBC shall be conformed.

2.6.7 Fast Bloc Insulated Concrete Form (ICF) (M/s Fast Bloc Building System)

Brief Description

The Fast Bloc Building System (Fast Bloc) is stay-in-place, formwork for reinforced concrete, post and beam construction, thus creating skeleton with required strength within the wall. In the System, Expanded Polystyrene (EPS) blocks are stay in place forms which provide insulation and sound barrier. Concrete and rebar shall be installed along the wall as per design requirement.

Standard Panels

Standard Fast Bloc has two different sizes as below;

1. 15.10 cm (6 inches) x 30.50 cm (12 inches) x 121.00 cm (48 inches),
2. 20.32 cm (8 inches) x 30.50 cm (12 inches) x 121.00cm (48 inches)

These two sizes can be assembled to cater the needs of any project. The spacing of the cells allows for walls to be reinforced based on the needs of the project, location, number of stories, and other parameters based on structural design. As per the requirement, Lintel blocks shall be used.

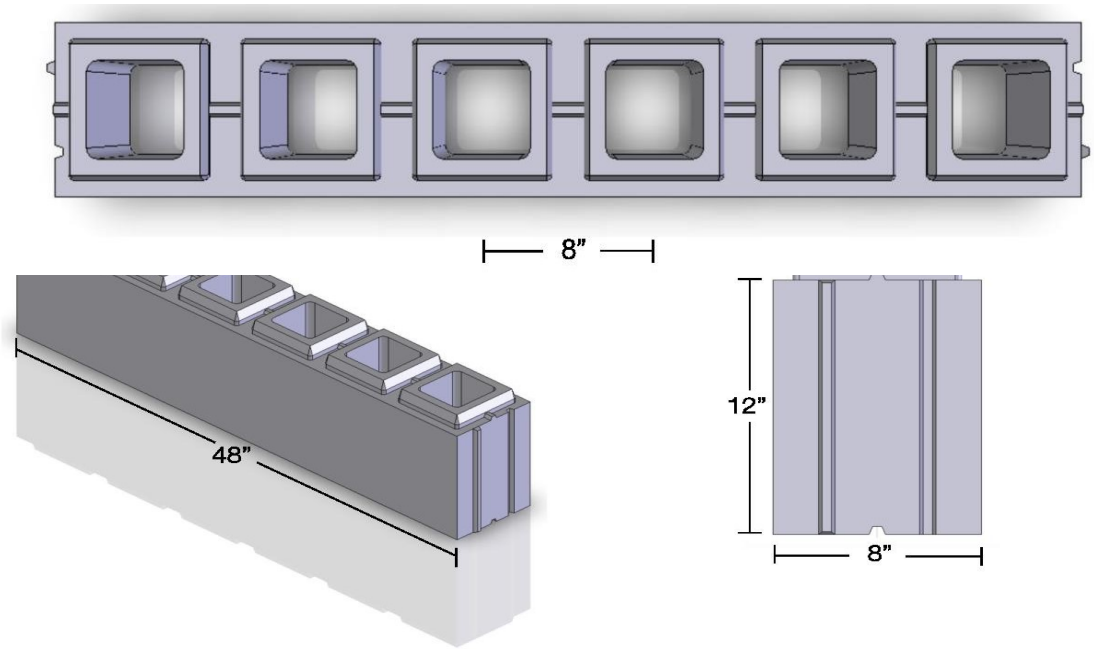
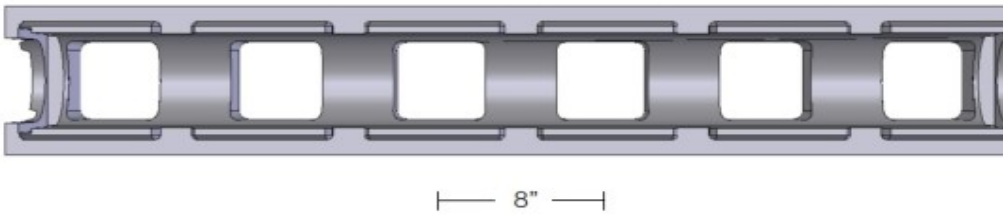


Fig. FastBloc®



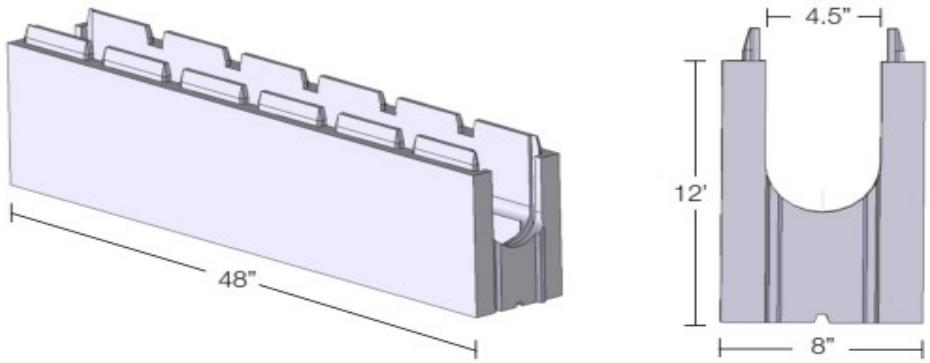


Fig. Fast Bloc® for Lintel

Walling System

To construct a Fast Bloc wall, parts shall be assembled similar to "Lego" blocks, by placing the pieces and form walls, known as "reinforced post and beam construction."
The plugs need to be placed in the cells that do not have vertical rebar reinforcement (per structural calculations), so they are not filled with concrete. The end caps provide an enclosure for the lintel at the end of walls. The vertical cells that are not filled with concrete can be used for electrical and / or plumbing.
Before pouring concrete, end plugs shall also be placed in the lintel beams at the end of walls to seal the blocks horizontally.
Utility Installation
The utilities shall be inserted before filling the walls with concrete. The utilities need to be properly placed in the foundation prior to installation of Fast Bloc in order to align with the center of the wall and an open Fast Bloc cell. It is important that the utilities do not interfere with the cells used for concrete and rebar, otherwise the utilities could cause a discontinuity in the concrete and steel and create a cold joint. The large-diameter pipes shall be put outside of the wall. The electrical boxes or load centers are to be placed prior to casting of the walls so they are drowned in concrete. Holes can be cut into Fast Bloc® walls where utility outlets are required.

Floor/Slab

In-situ RCC slab as per IS:456:2000 shall be provided. Speed floor as per design may also be provided.

Structural Aspects

The buildings constructed with the system walls shall be designed as reinforced concrete structure since the parameters required for their design are the same as needed for traditional reinforced concrete. The building shall be designed in accordance with IS 456:2000, as applicable.

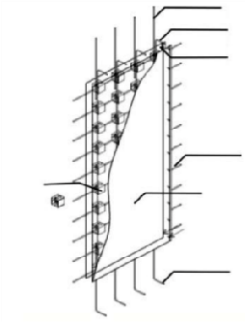
Foundation shall be specifically designed in accordance with provision given in IS 1904:2005. When performing the assembly of the foundation, depending on the type, vertical reinforcement rods (rebar) shall necessarily be inserted.

The structural design calculations should clearly demonstrate structural integrity and stability including connection details. In addition, any other requirement regarding safety against earthquake, cyclone shall be ensured by the designer as per prevailing codal requirements. All relevant Indian Standards/ requirement of NBC shall be conformed.

2.6.8 Plaswall Panel System (M/s FTS Buildtech Pvt. Ltd)

Plaswall Panel System is a lost in place formwork, where two fiber cement boards (FCB) of 6mm thickness each and HIMI spacers (High Impact Molded Inserts) bonded between two sheets of FCB(in-situ) are erected to produce straight-to-finish panels. A monolithic structure is then created by filling the entire structure with M20 or high ergrade of concrete as per the design. Additional load capacity can be obtained by providing extra reinforcing bars and/or by increasing grade of the concrete.

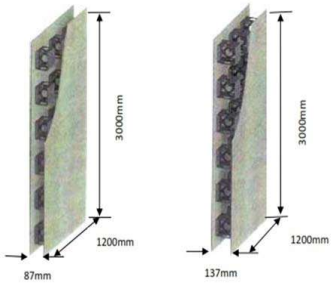
An Isometric View of the Plaswall is shown in Fig. 1 below:



STARTER BARS FOR NEXTFLOOR SHEAR CONNECTOR BAR EXT.
FROM VERT.REINF.
SHEAR CONNECTOR BAR EXT. FROM VERT.REINF.

HOTIZONTALREINF.BAR

SPACER
FCB BOARD



STARTER BARS FROM FOUNDATION

3.1 SIZE OF PANELS

3.2 Panels are normally produced in sizes and dimensions as below:

3.3 Length: 2400mm/3000 mm

3.4 Width: 1200 mm

3.5 Thickness: 87 mm, 112 mm, 137 mm, 162 mm & 230 mm including two fiber cement boards of 6mm thickness each and infill of concrete of 75mm, 100mm,125mm, 150mm and 218mm. The dimensional sketches are shown in Fig.

Raw Materials

- Fiber cement board shall be 100% as best osfree and conform to TypeA, Category 3 min. as stipulated in IS14862:2000.
- RecycledplasticspacersmadeofHighImpactMoldedInsertsshallconformtothes pecificationsoftheManufacturer.
- PU Adhesive Glue shall conform to the specifications of the manufacturer.
- Putty shall conform to IS 419:1967.
- Cement, sand, aggregate and reinforcement steel shall be as per the relevant Indian Standards.

Construction, Installation and Jointing Procedure of Plaswall
Foundation
The foundation type as raft, strip, isolated footing shall be decided based on bearing capacity of the soil, site condition, etc. However, the provision for starter bars for walls shall be ensured in all foundation scenarios. Typical sketch for starter bars from foundation are given below (Fig.7).

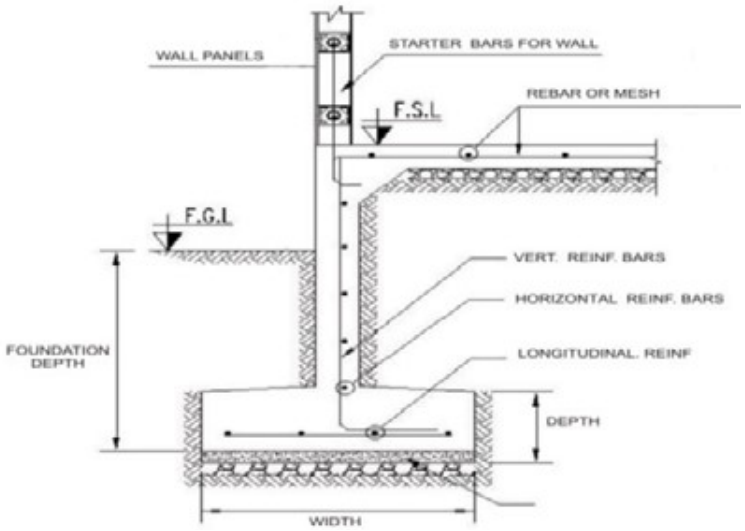


Fig. 7 Typical Strip footing

Panel Installation
Installation
The panel shall be lifted slightly and then placed along the bottom angles. The panel shall be plumbed at edge and face sides with provision of shims, if needed.
- The panel shall be screwed both sides at bottom at 250 mm center to center, while glue is applied & tacky. If glue is not available, spacing shall be kept at 200mm center to center.
- Support the temporarily angle installed on other side of panel to hold it in position for concreting (Fig. 8)
- Corner connection details shall be followed as shown in Fig. 9.



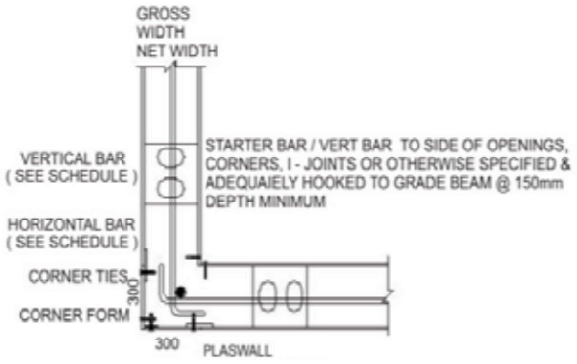


Fig. 8 Diagonal bracing Fig. 9 Corner connection

T-Section

- After installing the primary walls, mark the place where corner will be constructed.
- The joiner stud shall be placed and marked by pencil to have a vertical line reference.
- The joiner stud shall be moved up by 60mm from slab to bottom of joiner stud. The stud hole shall be marked by pencil.
- The marked slots shall be cut by 100mm angle grinder with dry type diamond blade.
- Reinforced dowels shall be prepared, inserted & tied just after screwing the joiner stud corner connection.(Fig.9)
- In case, the holes intersect with panel stud of the primary wall, the portion of primary stud shall be cut to accommodate the marked holes for T-connection. One 12mm vertical bar shall be provided as replacement.
- In case of cross-connection, horizontal bars shall be provided.

Nib End Wall Detail

- For nib, end cap shall be provided.
- Glue shall be applied on end cap stud which shall be inserted to correct position and screwed. (Fig. 10)

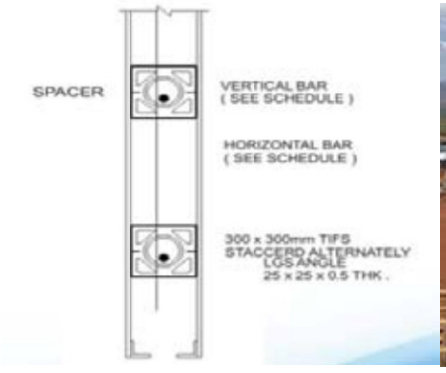




Fig. 10 Nib End Wall Detail ***Fig. 11 Door & Window Jambs***

Door & Window Jambs Installation

- Light gauge door & window jambs shall be provided for the panels Door

jambs shall be installed along with the panel. (Fig. 11)

- Window jambs shall be installed (not fixed) to accommodate concrete at window sills. This will eliminate honey-comb and ease pouring of concrete.
- The window sill shall be overflowed by concrete and then push down window frame.
- The lintel panel shall be screwed to press down the window frame. Spacing of screws shall be the same.

Embedment of Services

After installation of the panels, electrical and plumbing pipes shall be inserted into the panel as per the drawings.

Placing of Reinforcement

Placing of reinforcement of required grade shall be as per the structural drawings and IS 456:2000 and IS 1139:1966.

Concreting

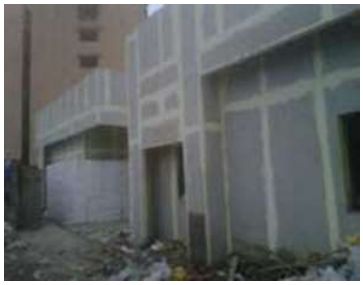
After placing of reinforcement and services in the panel, designed grade/mix of concrete shall be poured manually or by Pumping system. The concrete shall be poured from top of the wall or by cutting slit and attaching chute in the panel. Mix shall be prepared in accordance with section 9.2 of IS 456:2000. Aggregate of max. size 6 to 10mm shall be used. Slump should be between 175mm to 200mm.

Pouring of concrete

- After proper mixing of concrete as per the mix, concrete shall be poured manually into the panel from top of the wall or by cutting slit and attaching chute in the panel. The first pour of concrete should be of 300mm height and after setting, concrete shall be poured up to 800mm as above.
- After setting time of each pour of concrete, keep pouring upto 800mm height and continue till height of the wall.
- Above process shall be followed horizontally for different walls. This will allow setting time of concrete for the previous wall while the next wall is being poured.
- Setting time of concrete shall be min. three hours but during that time other walls shall be poured. Since the project quantum will be big, there will be enough walls available to pour.
- Rubber mallet shall be used for tapping the wall while pouring the concrete to avoid honey comb/segregation.

Joint Treatment

After walls are completely filled and mix dried, joint treatment shall be done using fiber mesh tape and putty. (See Figs. 12 & 13)



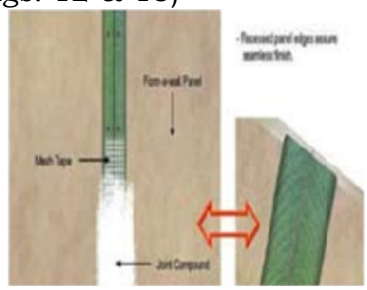


Fig.12 Yellow Putty with Fiber mesh tapeFig.13 Joint Treatment

Construction of Slab

Once construction of panels is completed, slab construction shall be done as per the structural drawings with wall reinforcement and connection with slab reinforcement.
All relevant Indian Standards/ requirement of NBC shall be conformed.

SECTION-G

DRAWINGS OF EWS HOUSING for 6 LIGHT HOUSE PROJECT SITES

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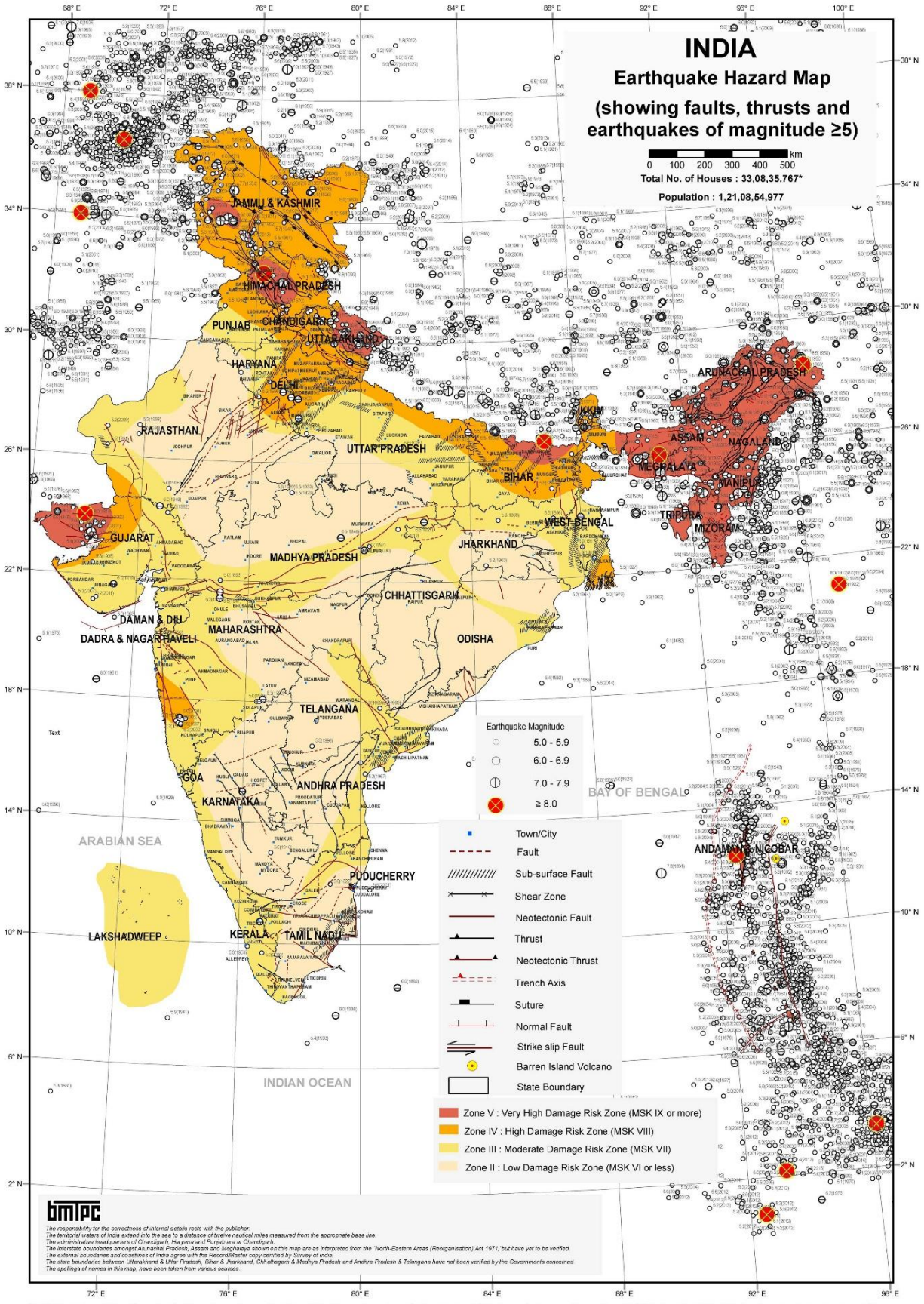
2.6.6 Floor Plans

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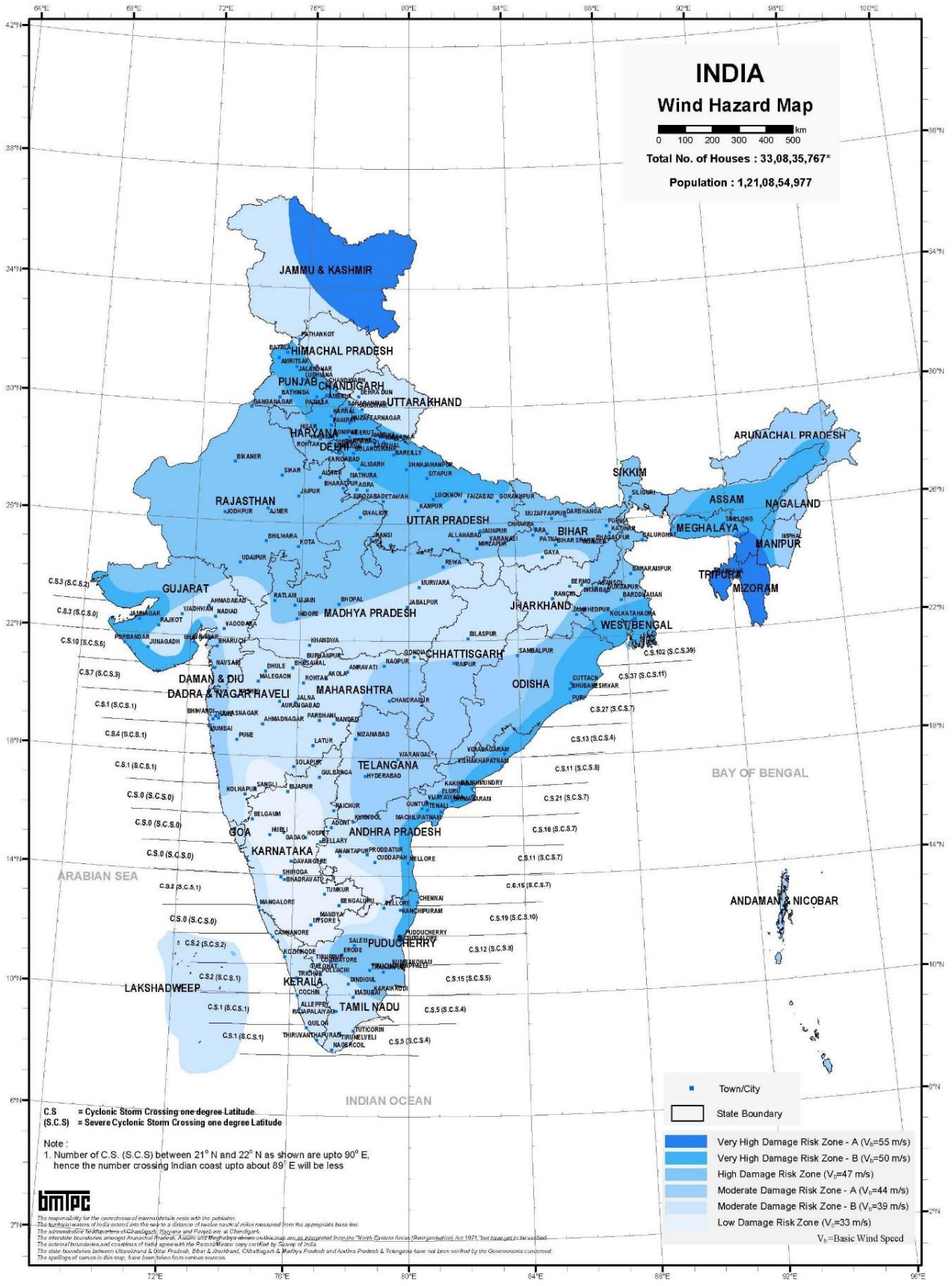
1 Maps as per Vulnerability Atlas of India 2019

1.1 Earthquake Hazard Map



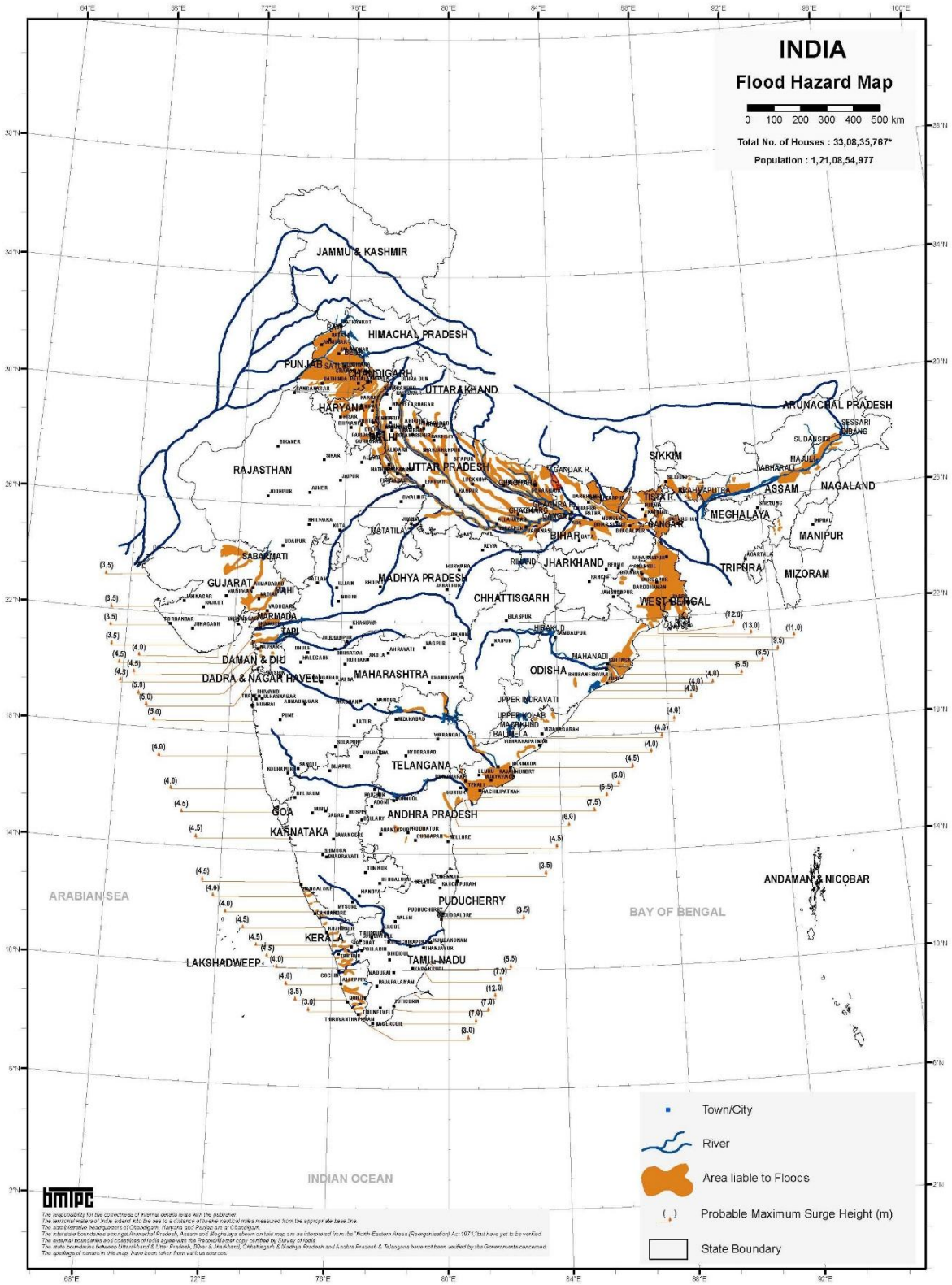
BMTPC : Vulnerability Atlas - 3rd Edition : Peer Group, MoHUA, GOI; Map is Based on digitised data of SOI; Seismic Zones of India Map IS 1893 (Part I): 2002, BIS; Earthquake Epicentre from IMD; Seismotectonic Atlas of India and its Environs, GSI; Houses/Population as per Census 2011; *Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

1.2 Wind Hazard Map



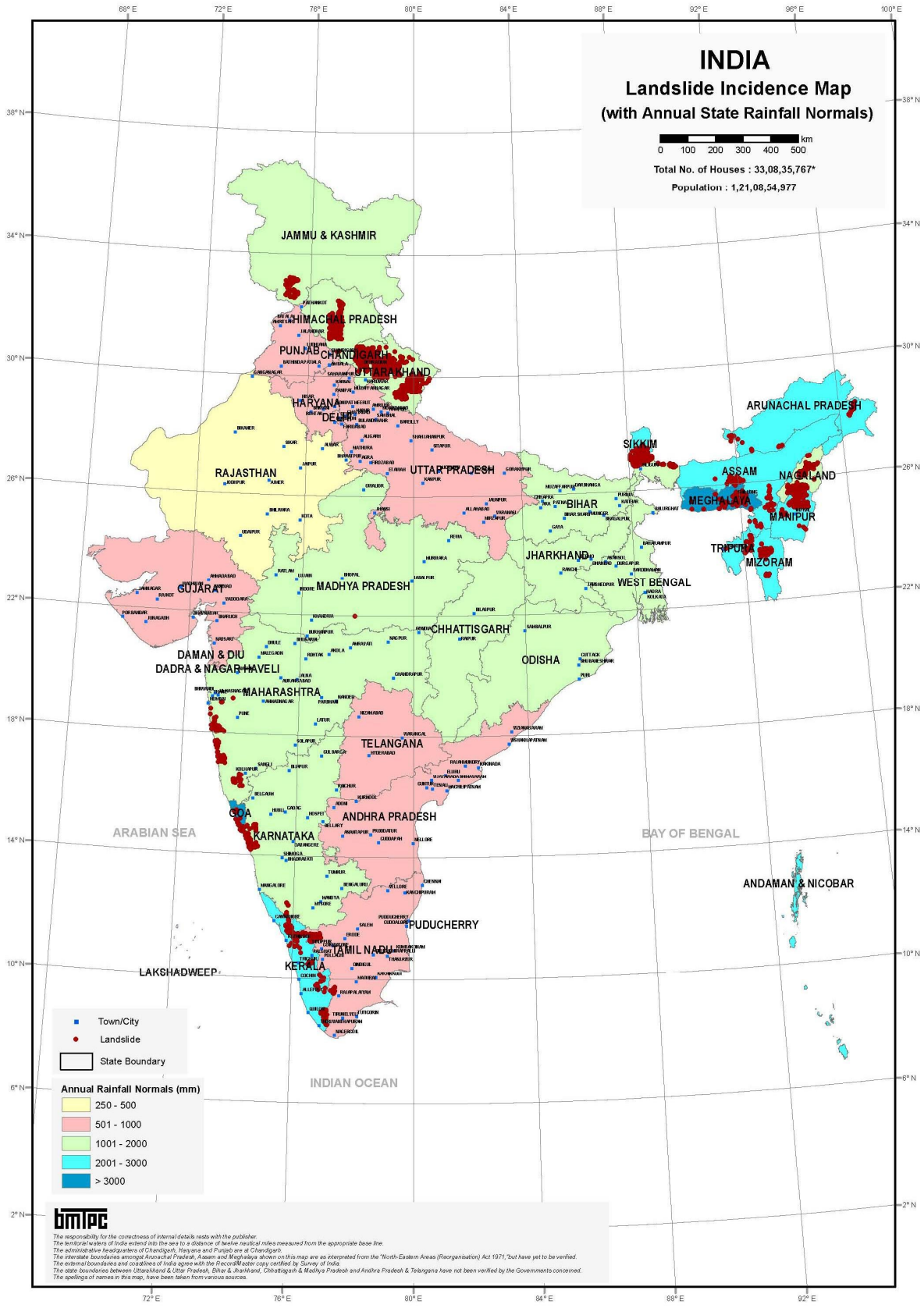
BMTPC : Vulnerability Atlas- 3rd Edition; Peer Group, MoHUA; Map is Based on digitised data of SOI, GOI; Basic Wind Speed Map National Building Code: 2016; Cyclone Data, 1891-2015, IMD, GOI. Houses/Population as per Census 2011; *Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

1.3 Flood Hazard Map



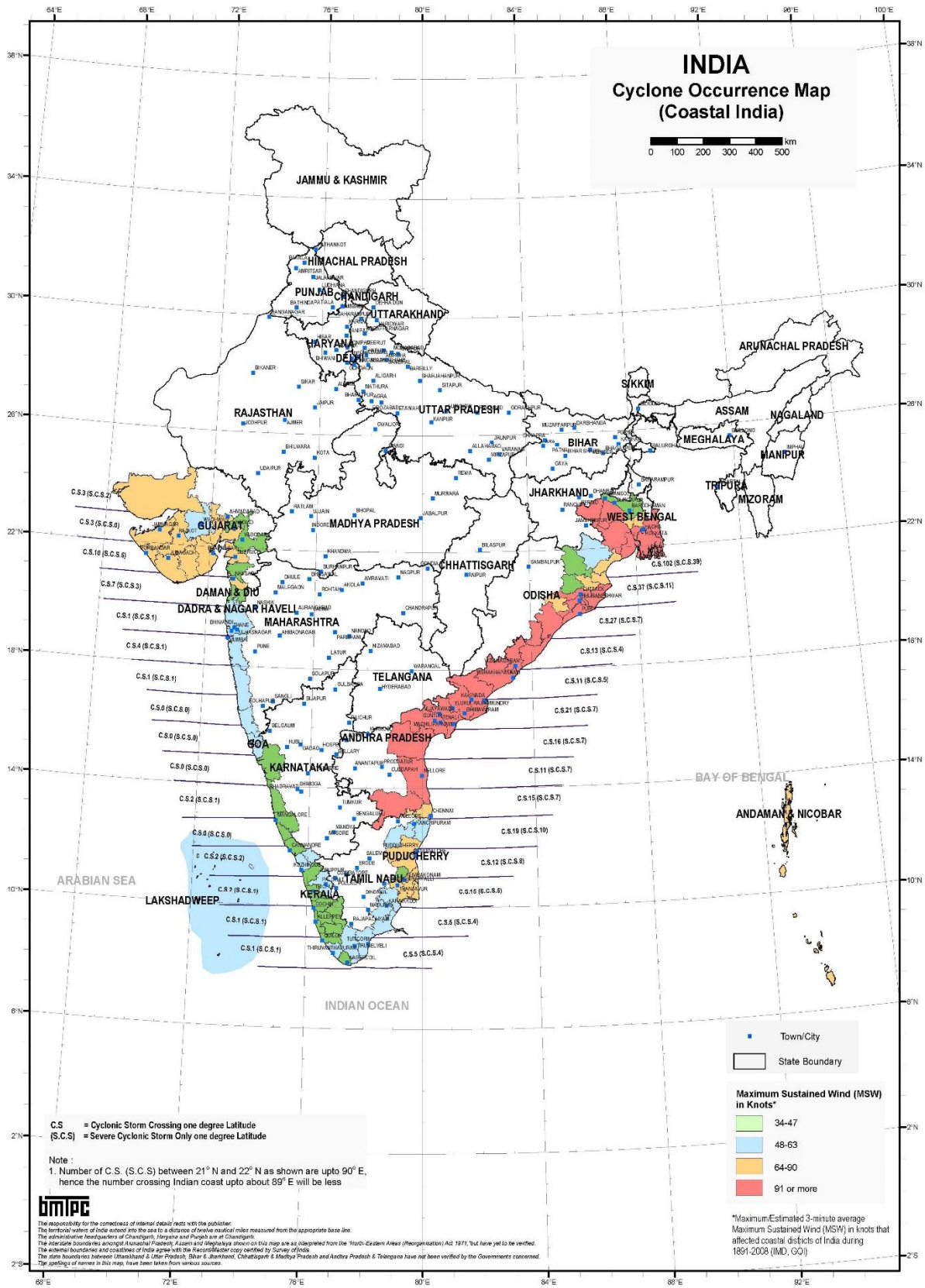
BMTPC : Vulnerability Atlas - 3rd Edition; Peer Group, MoHUA; Map is Based on digitised data of SOI, GOI; Census of India 2011; Flood Atlas (1987),Task Force Report (2004), C.W.C., G.O.I. Houses/Population as per Census 2011; * Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

1.4 Landslide Incidence Map



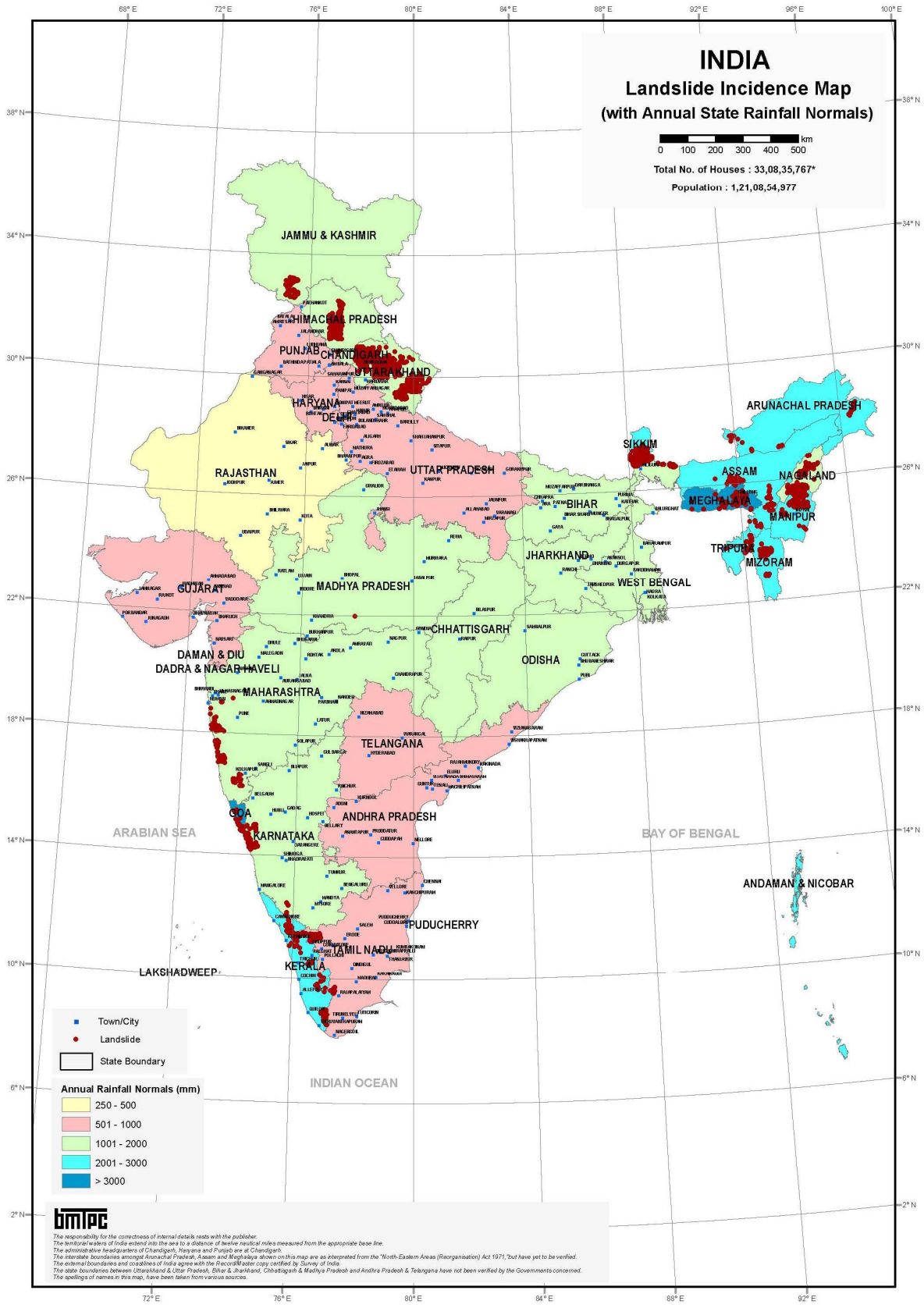
BMTPC: Vulnerability Atlas - 3rd Edition: Peer Group, MoHUA,GOI: Map is Based on digitised data of SOI; Landslide Incidence data GSI; Annual Rainfall data IMD. Houses/Population as per Census 2011;
* Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

1.5 Cyclone Occurrence Map



BMTPC : Vulnerability Atlas- 3rd Edition; Peer Group, MoHUA; Map is Based on digitised data of SOI, GOI; Maximum Sustained Wind (MSW) Data from IMD, GOI. Disclaimer: The maps are solely for thematic presentation.

1.6 Thunderstorm Incidence Map



BMTPC: Vulnerability Atlas - 3rd Edition: Peer Group, MoHUA,GOI: Map is Based on digitised data of SOI; Landslide Incidence data GSI; Annual Rainfall data IMD. Houses/Population as per Census 2011;
* Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

2 Drawings of 6 LHP sites

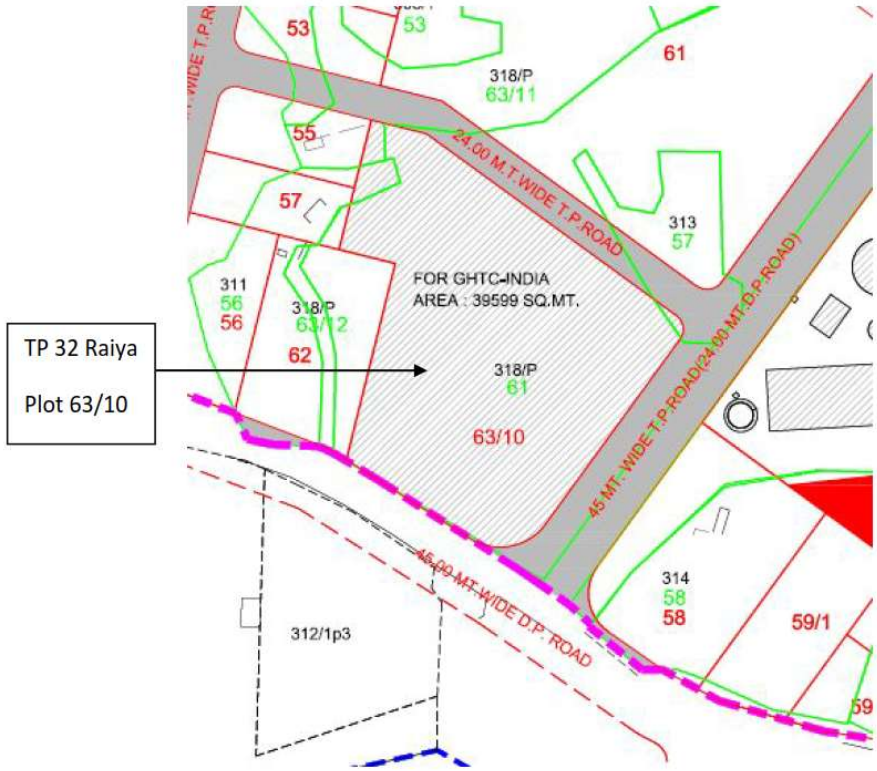
2.1 LHP1 Gujarat

2.1.1 Location Map

Map of the site showing distance from the city



Proposed Plot Details



DRAFT TOWN PLANNING SCHEME RAJKOT NO. -32(RAIYA)

MAP SHOWING ORIGINAL PLOTS AND FINAL PLOT - MAP NO. 3

LEGEND:-

- R.M.C. BOUNDRY
- BOUNDRY OF T.P. SCHEME
- BOUNDRY OF ORIGINAL PLOT
- BOUNDRY OF FINAL PLOT
- PROPOSED T.P. ROAD
- RESERVATION PLOTS
- 32 R.SURVEY.NO.
- EXIT.LAKE
- 32 ORIGINAL PLOT NO.
- 32 FINAL PLOT NO.

To Jamngar road
45.00 M.T.WIDE EXIT D.P.ROAD
ADJ. VILLAGE BOUNDARY OF GHANTESHWER
ADJ. SURVEYNO OF VILLAGE RAIYA(RMC)
LAKE NO.1
45 MT. WIDE T.P.ROAD(24.00 MT.D.P.ROAD)
40.00 M.T.WIDE T.P.ROAD
24.00 MT. WIDE T.P. ROAD
GARDEN-1
GARDEN-2
GARDEN-3
GARDEN-4
GARDEN-5
GARDEN-6
GARDEN-7
GARDEN-8
GARDEN-9
GARDEN-10
GARDEN-11
GARDEN-12
GARDEN-13
GARDEN-14
63/4/A SOCIAL INFRA.
63/4/B SOCIAL INFRA.
63/4/C COMM.SALE
63/4/D COMM.SALE
63/5/A SOCIAL INFRA
63/5/B S.E.W.S.H.
63/5/C RESI SALE
18/A SOCIAL INFRA
63/3/A GARDEN
63/3/B GARDEN
63/2/A SOCIAL INFRA.
63/1/A COMM.SALE
62/A GARDEN
44/A GARDEN
34/A SOCIAL INFRA
59/A SOCIAL INFRA
LAKE NO.2
LAKE NO.3
P4
R.M.C. S.T.P.
ADJ. VILLAGE BOUNDARY OF VAJDIGADH
ADJ. VILLAGE BOUNDARY OF VEJAGAM
EXISTING 45 MT.WIDE SECOND RING ROAD
75.00 MT WIDE D.P.ROAD
To VillageRaiya
To kalavad road
ADJ. VILLAGE BOUNDARY OF MUNJKA

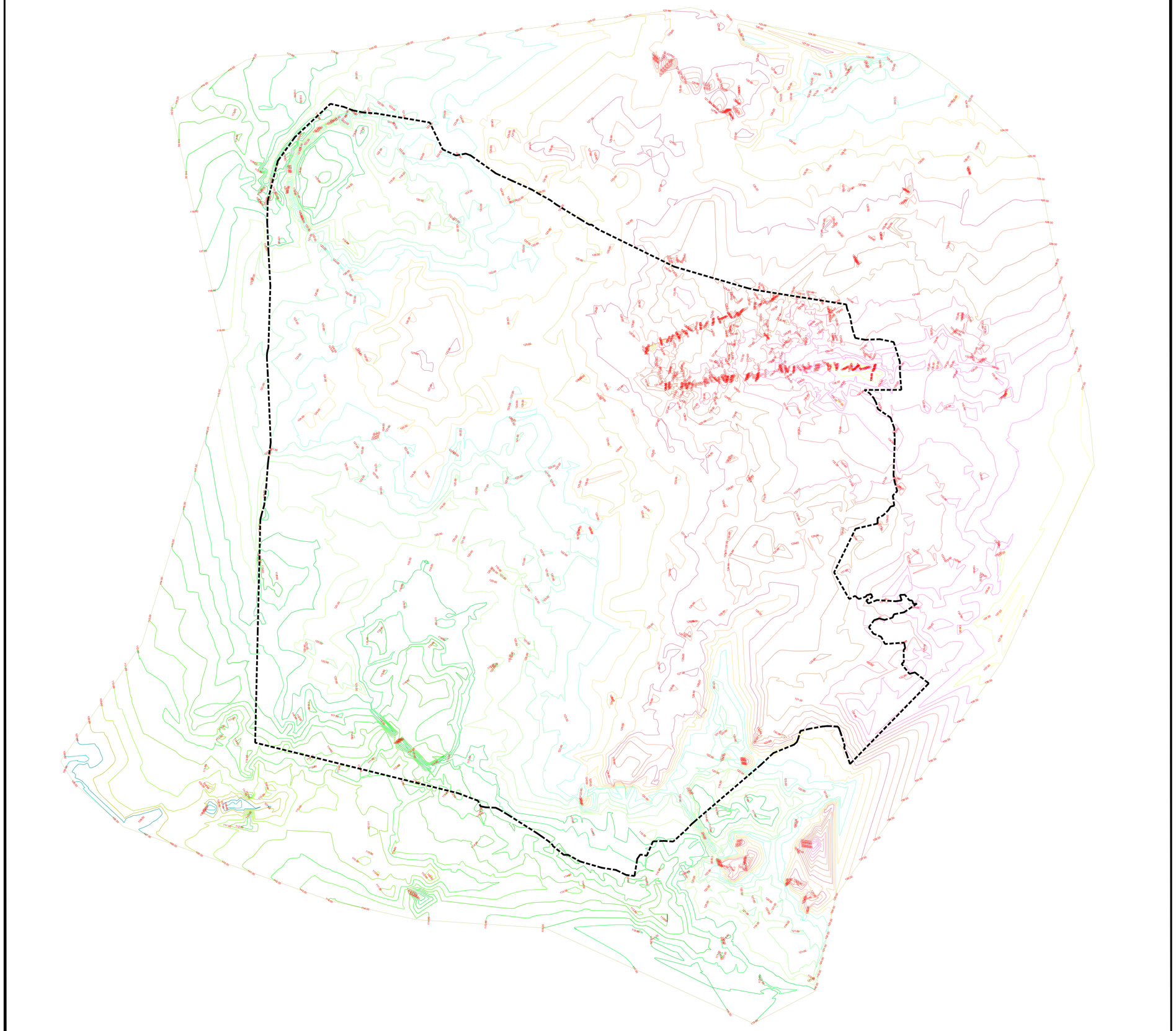
RAJKOT MAHANAGAR SEWA SADAN

Scale : 1cm = 30 mt.

TOWNPLANNING OFFICER
RAJKOT MAHANAGAR SEWA SADAN

COMMISSIONER
RAJKOT MAHANAGAR SEWA SADAN

2.1.2 Total Station Survey Map



RAJKOT MUNICIPAL CORPORATION

N

Scale : 1cm = 30 mt.

2.1.3 Soil Testing Report

GEOTECHNICAL INVESTIGATION REPORT

GREEN FIELD AREA – RAJKOT SMART CITY

CONSULTANTS	**PRIME MERIDIAN SURVEYS PVT. LTD,** New No.68/6, Ground Floor Madhangi Flat, Jones Road, Saidapet, Chennai-15 Ph. No. 044-23813667/68 Mobile: 9444020824/9500057519 Email : meridiansurveys@gmail.com Website: www.primemeridiansurveys.com
CLIENT	**AECOM INDIA PVT LTD,** Gurgaon-122002
PROJECT	**PROPOSED CONSTRUCTION OF INDUSTRIAL DEVELOPMENT AT RAJKOT, GUJARAT**
TITLE	**GEOTECHNICAL INVESTIGATION REPORT**

0	**04-10-2018**	**PMSPL/AECOM INDIA PVT LTD/285/2018-19**	
REV.	**DATE**	**REPORT NUMBER**	**PREP. BY**

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CHAPTER-1

INTRODUCTION

1.0 Preamble

Prime Meridian Surveys Pvt. Ltd., Chennai proposed to construct an **Industrial Development at Rajkot, Gujarat.**

For the purpose of designing the foundations, the responsibility of carrying out suitable soil investigation was entrusted to **M/s. Geo Mines ENGINEERS Pvt. Ltd., Chennai.**

This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems.

1.1 Scope of Work

- Sinking Fifteen Standard Soil investigation bore holes of 150mm diameter up to depth below existing ground level where SPT>100 or as directed by the engineer-in-charge.
- Conducting Standard Penetration Test (SPT) at regular depth intervals.
- Collection of Split Spoon Samples or Disturbed Soil Samples
- Collection of water samples from each bore hole.
- Conducting relevant laboratory test results.

1.2 Structure of the Report

- Contents
- Introduction
- Investigation Methodology & Test Results
- Figures & Tables
- Sub-Surface Stratification
- Foundation Systems
- Recommendations
- Annexure (Design Computations)

CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 Field Testing:

2.1 Preamble:

Fifteen standard soil investigation boreholes were put. The equipment used and the methodology adopted to carry out the fieldwork is described below.

2.2 Equipment Used and Method of Drilling:

2.2.1 Equipment Used

The equipment used for performing the drilling operations is a Calyx Rotary Drill Rig with direct mud circulation technique. The drill mud used was made out of Sodium Bentonite.

2.2.2 Methodology of drilling

In the soil strata, the drilling operations have been carried out using special drill bits and cutters coupled with direct mud circulation.

2.3 In-Situ Strength Tests:

2.3.1 Standard Penetration Test:

Standard penetration tests were conducted at the borehole locations, in accordance with IS: 2131. The tests were conducted at every change of strata up to the depth of termination of the borehole as directed by the engineer-in-charge.

2.4. Collection of Samples:

2.4.1 Disturbed Soil Samples

The SPT-samples collected were used as disturbed soil samples. These samples were used for visual and physical identification and for conducting laboratory classification tests as per I.S.1498-1970.

2.4.2 Ground Water

For conducting suitable chemical tests, the ground water sample was collected from the respective boreholes.

2.5 Summary of Field Work

The locations of the boreholes are shown in site plan given in Fig.2.0. The soil profiles obtained at each location is shown in Fig.2.1 to 2.15.

2.6 Laboratory Testing:

2.6.1 Coarse Grained Samples:

2.6.1.1 Grain size Analysis Tests:

On the coarse grained samples, grain size distribution tests were conducted as per I.S.2720 (Part 4)-1985, to know the gradation characteristics and to classify them. These results are presented in Tables 2.1 to 2.15.

2.6.2 Fine Grained Samples:

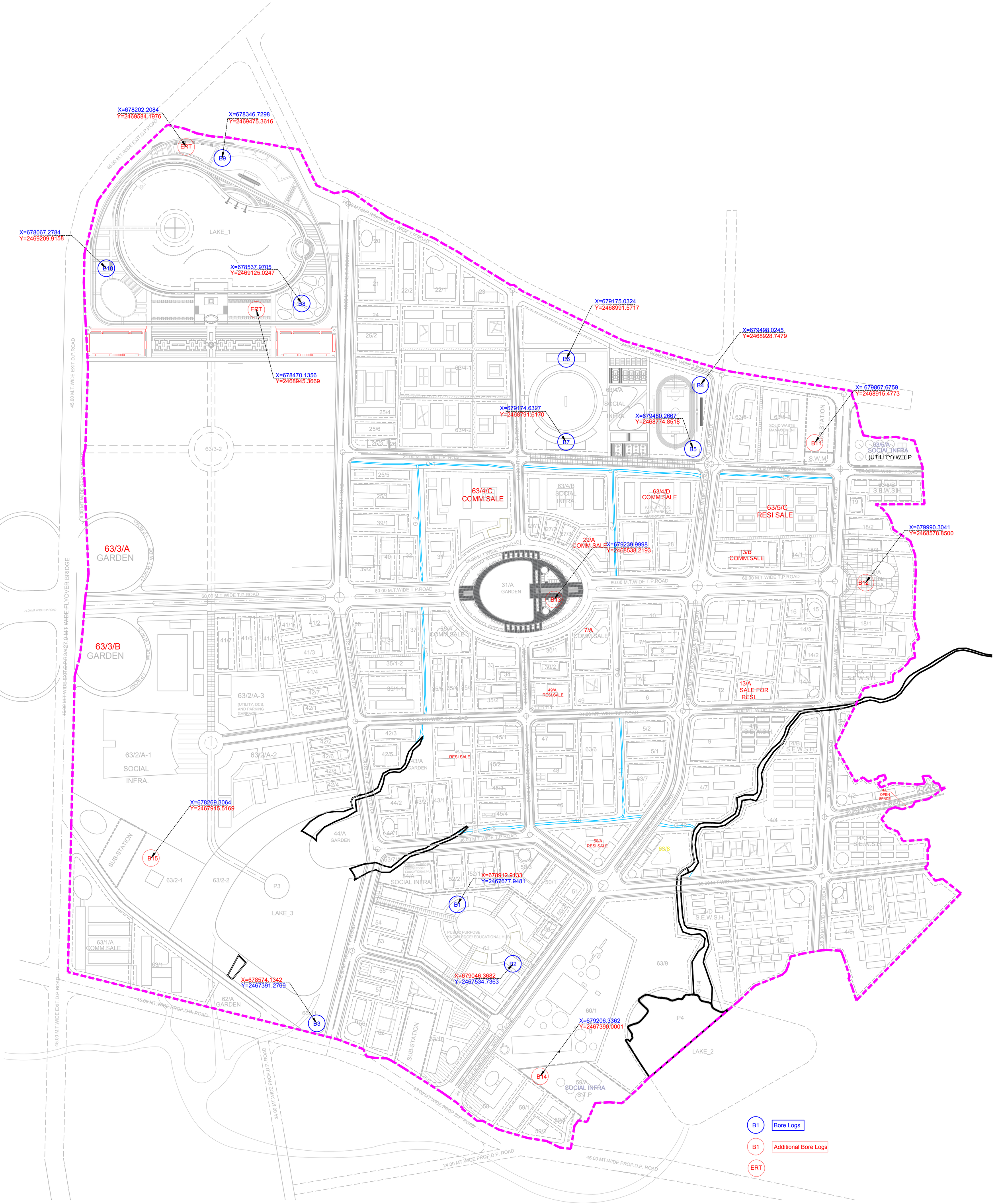
2.6.2.1 Index Property – Free Swell Tests:

Atterberg Limits were carried out on fine grained soil samples to evaluate the limits of different consistency states. Generally Liquid limits, Plastic limits and Shrinkage Limits tests were conducted as per I.S.2720 (Part-5)-1985 and I.S.2720 (Part 6)-1972. On such type of soil strata encountered at the investigation locations, such tests were conducted and the test results are presented in Tables 2.1 to 2.15.

2.6.3 Chemical Analysis Tests:

2.6.3.1 Water/Soil Samples:

On representative water/soil samples, chemical analysis tests were conducted to estimate pH, Chlorides and Sulphates. These results are presented in Table-2.16.


X=678202.2084
Y=2469584.1976
ERT
X=678346.7298
Y=2469475.3616
B9
45.00 M.T.WIDE EXIT.D.P.ROAD
X=678067.2784
Y=2469209.9158
B10
X=678537.9705
Y=2469125.0247
B8
ERT
X=678470.1356
Y=2468945.3669
LAKE_1
63/3-2
63/3/A
GARDEN
63/3/B
GARDEN
63/2/A-3
(UTILITY, DCS, AND PARKING GARRAGE
63/2/A-1
SOCIAL
INFRA.
63/2/A-2
63/1/A
COMM.SALE
SUB-STATION
P3
LAKE_3
44/A
GARDEN
62/A
GARDEN
63/4/C
COMM.SALE
63/4/B
SOCIAL
INFRA.
63/4/D
COMM.SALE
(UTILITY, DCS, AND PARKING GARRAGE
63/4/A
SOCIAL
INFRA.
63/5/C
RESI SALE
63/5/A
SOCIAL INFRA
(UTILITY) W.T.P
63/5/B
S.B.W.S.H.
63/5-1
63/5-2
SOLID WASTE MANAGEMENT
S.T.P STATION
S.W.M
31/A
GARDEN
29/A
COMM.SALE
13/B
COMM.SALE
35/A
COMM.SALE
7/A
COMM.SALE
49/A
RESI.SALE
45/A
RESI.SALE
43/A
GARDEN
50/A
RESI.SALE
54/A
SOCIAL INFRA
PUBLIC PURPOSE KNOWLEDGE/ EDUCATIONAL HUB
59/A
SOCIAL INFRA
S.T.P
13/A
SALE FOR RESI.
4/A
S.E.W.S.H.
4/B
S.E.W.S.H.
4/C
S.E.W.S.H.
4/D
S.E.W.S.H.
4/E
OPEN SPACE
63/8
63/9
P4
LAKE_2
X=679175.0324
Y=2468991.5717
B6
X=679498.0245
Y=2468928.7479
B4
X= 679867.6759
Y=2468915.4773
B11
X=679174.6327
Y=2468791.6170
B7
X=679480.2667
Y=2468774.8518
B5
X=679990.3041
Y=2468578.8500
B12
X=679239.9998
Y=2468538.2193
B13
X=678269.3064
Y=2467915.5169
B15
X=678912.9133
Y=2467677.9481
B1
X=679046.3682
Y=2467534.7363
B2
X=678574.1342
Y=2467391.2769
B3
X=679206.3362
Y=2467390.0001
B14
45.00 MT.WIDE PROP.D.P. ROAD
24.00 MT.WIDE PROP D.P. ROAD
24.00 MT.WIDE T.P.ROAD/45 MT. WIDE T.P.ROAD
24.00 MT. WIDE T.P.ROAD
60.00 M.T.WIDE T.P.ROAD
36.00 MT. WIDE T.P. ROAD
B1 Bore Logs
B1 Additional Bore Logs
ERT

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-01

Co-ordinates: X-678912.9133, Y-2467677.9481

Started On : 10/09/2018; Ended On : 10/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details				Graphical Representation of SPT		Relative Density/Consistency	Type of Sample
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	0 10 20 30 40 50 60 70 80 90		
0.50			Soft Disintegrated Rock							V.Dense	DS
				1.00	10cms Penetration for 50 Blows					V.Dense	SS
			Weathered Rock	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS
3.00				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.1 Soil Profile at BH-01 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-02

Co-ordinates: X-679046.3682, Y-2467534.7363

Started On : 10/09/2018; Ended On : 10/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details					Graphical Representation of SPT												Relative Density/Consistency	Type of Sample
									0	10	20	30	40	50	60	70	80	90				
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value														
			Soft Disintegrated																		V.Dense	DS
0.70			Rock																			
				1.00	09cms Penetration for 50 Blows																V.Dense	SS
			Weathered	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded																V.Dense	SS
			Rock																			
				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded																V.Dense	SS
3.50				3.50	Nil Penetration for 50 Blows, SPT Hammer Rebounded																V.Dense	SS

Bore Hole Terminated at a depth of 3.50m below the existing ground level

Fig. 2.2 Soil Profile at BH-02 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-03

Co-ordinates: X-678574.1342, Y-2467391.2769

Started On : 13/09/2018; Ended On : 13/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details					Graphical Representation of SPT		Relative Density/Consistency	Type of Sample
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	0 10 20 30 40 50 60 70 80 90			
0.50			Brownish Soft Silty Sandy Clay								Soft	DS
0.90			Greyish to Whitish Medium Dense Silty Clayey Fine Sand mixed with lime								M.Dense	DS
				1.00	03cms Penetration for 50 Blows						V.Dense	SS
			Weathered Rock	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded						V.Dense	SS
				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded						V.Dense	SS
3.50				3.50	SPT Hammer Rebounded						V.Dense	SS
			Soft		Rock Core Recovery: 20cm						V.Dense	CS
4.50			Rock	4.50								

Bore Hole Terminated at a depth of 4.50m below the existing ground level

Fig. 2.3 Soil Profile at BH-03 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-04

Co-ordinates: X-679498.0245, Y-2468928.7479

Started On : 15/09/2018; Ended On : 15/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details: Depth of SPT below E.G.L (m)	SPT - Details: 0-15 cm	SPT - Details: 15-30 cm	SPT - Details: 30-45 cm	Graphical Representation of SPT: N-Value (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
0.30			Brownish to Reddish Dense Silty Sandy Gravels						Dense	DS
				1.00	05cms Penetration for 50 Blows				V.Dense	SS
			Weathered Rock							
2.00				2.00	SPT Hammer Rebounded				V.Dense	SS
			Soft		Rock Core Recovery: 25cm				V.Dense	CS
3.00			Rock	3.00						

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.4 Soil Profile at BH-04 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-05

Co-ordinates: X-679480.2667, Y-2468774.8518

Started On : 08/09/2018; Ended On : 09/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details					Graphical Representation of SPT											Relative Density/Consistency	Type of Sample
									0	10	20	30	40	50	60	70	80	90			
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value													
0.50			Soft Disintegrated Rock																	V.Dense	DS
				1.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
			Weathered Rock	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
2.50				2.50	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS

Bore Hole Terminated at a depth of 2.50m below the existing ground level

Fig. 2.5 Soil Profile at BH-05 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-06

Co-ordinates: X-679175.0324, Y-2468991.5717

Started On : 09/09/2018; Ended On : 09/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details				Graphical Representation of SPT		Relative Density/Consistency	Type of Sample
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	0 10 20 30 40 50 60 70 80 90		
0.40			Soft Disintegrated Rock							V.Dense	DS
				1.00	04cms Penetration for 50 Blows					V.Dense	SS
			Weathered Rock	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS
3.00				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.6 Soil Profile at BH-06 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-07

Co-ordinates: X-679174.6327, Y-2468791.6170

Started On : 09/09/2018; Ended On : 09/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details				Graphical Representation of SPT		Relative Density/Consistency	Type of Sample
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	0 10 20 30 40 50 60 70 80 90		
0.50			Soft Disintegrated Rock							V.Dense	DS
				1.00	02cms Penetration for 50 Blows					V.Dense	SS
			Weathered Rock	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS
2.50				2.50	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS

Bore Hole Terminated at a depth of 2.50m below the existing ground level

Fig. 2.7 Soil Profile at BH-07 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-08

Co-ordinates: X-678537.9705, Y-2469125.0247

Started On : 11/09/2018; Ended On : 11/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details					Graphical Representation of SPT											Relative Density/Consistency	Type of Sample
									0	10	20	30	40	50	60	70	80	90			
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value													
			Brownish Dense																	Dense	DS
0.70			Silty Sandy Gravels																		
				1.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
			Weathered Rock	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
2.50				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.8 Soil Profile at BH-08 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-09

Co-ordinates: X-678346.7298, Y-2469475.3616

Started On : 14/09/2018; Ended On : 14/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details					Graphical Representation of SPT											Relative Density/Consistency	Type of Sample
									0	10	20	30	40	50	60	70	80	90			
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value													
0.60			Brownish to Greyish Soft Silty Clay																	Soft	DS
0.90			Greyish to Whitish Dense Silty Clayey Fine Sand mixed with kankars																	Dense	DS
			Weathered Rock	1.00	06cms Penetration for 50 Blows															V.Dense	SS
				2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
3.00				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.9 Soil Profile at BH-09 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-10

Co-ordinates: X-678067.2784, Y-2469209.9158

Started On : 11/09/2018; Ended On : 11/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details				Graphical Representation of SPT		Relative Density/Consistency	Type of Sample
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	0 10 20 30 40 50 60 70 80 90		
0.80			Brownish to Reddish Dense Silty Sandy Gravels							Dense	DS
			Weathered Rock	1.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS
				2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS
				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS
3.60				3.60	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS

Bore Hole Terminated at a depth of 3.60m below the existing ground level

Fig. 2.10 Soil Profile at BH-10 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-11

Co-ordinates: X-679867.6759, Y-2468915.4773

Started On : 12/09/2018; Ended On : 12/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details: Depth of SPT below E.G.L (m)	SPT - Details: 0-15 cm	SPT - Details: 15-30 cm	SPT - Details: 30-45 cm	Graphical Representation of SPT: N-Value	Graphical Representation of SPT: 0 10 20 30 40 50 60 70 80 90	Relative Density/Consistency	Type of Sample
0.50			Brownish to Reddish Dense Silty Sandy Gravels							Dense	DS
			Weathered Rock	1.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS
				2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS
3.00				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.11 Soil Profile at BH-11 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-12

Co-ordinates: X-679990.3041, Y-2468578.8500

Started On : 12/09/2018; Ended On : 12/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details					Graphical Representation of SPT											Relative Density/Consistency	Type of Sample
									0	10	20	30	40	50	60	70	80	90			
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value													
0.60			Brownish Soft Silty Clay																	Soft	DS
			Brownish to Greyish Very Dense Silty Clayey Fine Sand mixed with lime nodules	1.00	12	17	40	57												V.Dense	SS
1.60																					
			Weathered Rock	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
3.00				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.12 Soil Profile at BH-12 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-13

Co-ordinates: X-679239.9998, Y-2468538.2193

Started On : 13/09/2018; Ended On : 14/09/2018 G.W.T: 1.40m below existing ground level

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details: Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	Graphical Representation of SPT (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
			Brownish to Greyish Stiff Silty Clay	1.00	4	3	6	9		Stiff	SS
1.40											
			Greyish to Whitish Very Dense Silty Fine Sand mixed with kankars	2.00	26	33	40	73		V.Dense	SS
2.80											
			Weathered Rock	3.00	11cms Penetration for 50 Blows					V.Dense	SS
4.00				4.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded					V.Dense	SS

Bore Hole Terminated at a depth of 4.00m below the existing ground level

Fig. 2.13 Soil Profile at BH-13 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-14

Co-ordinates: X-679206.3362, Y-2467390.0001

Started On : 12/09/2018; Ended On : 12/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details					Graphical Representation of SPT											Relative Density/Consistency	Type of Sample
									0	10	20	30	40	50	60	70	80	90			
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value													
0.40			Filled Up Soil																	-	DS
0.90			Brownish to Greyish Soft Silty Clay mixed with lime																	Soft	DS
				1.00	07cms Penetration for 50 Blows															V.Dense	SS
			Weathered Rock	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
3.50				3.50	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS

Bore Hole Terminated at a depth of 3.50m below the existing ground level

Fig. 2.14 Soil Profile at BH-14 Location

Project : Proposed Construction of Industrial Development at Rajkot, Gujarat

Location: BH-15

Co-ordinates: X-678269.3064, Y-2467915.5169

Started On : 14/09/2018; Ended On : 15/09/2018 G.W.T: Not met within investigation depth

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details					Graphical Representation of SPT											Relative Density/Consistency	Type of Sample
									0	10	20	30	40	50	60	70	80	90			
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value													
0.30			Brownish to Reddish Dense Silty Sandy Gravels																	Dense	DS
				1.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
			Weathered Rock	2.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS
3.00				3.00	Nil Penetration for 50 Blows, SPT Hammer Rebounded															V.Dense	SS

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.15 Soil Profile at BH-15 Location

Table 2.1: Laboratory Test Result on the Soil Sample Collected from BH-01

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.50	-	DS	Soft Disintegrated Rock	-	-	-	-	-	2.66	-	19.3	-	-	-	Dense	33	12	15	31	9	0	-	-	SDR
0.50 to 3.00	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	20.6	-	-	-	V.Dense	41	9	21	16	13	0	5.20	42.30	SDR

Table 2.2: Laboratory Test Result on the Soil Sample Collected from BH-02

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.70	-	DS	Soft Disintegrated Rock	-	-	-	-	-	2.66	-	19.3	-	-	-	Dense	27	19	10	33	11	0	-	-	SDR
0.70 to 3.50	>100	SS	Weathered Rock	-	-	-	-	-	2.63	-	21.1	-	-	-	V.Dense	44	11	8	21	16	0	6.40	42.10	SDR

Table 2.3: Laboratory Test Result on the Soil Sample Collected from BH-03

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.50	-	DS	Silty Sandy Clay	33	85	16	69	0.8	2.68	0.9	14	-	70	-	Soft	0	0	0	11	11	78	-	-	CH
0.50 to 0.90	-	DS	Silty Clayey Fine Sand mixed with lime	-	-	-	-	-	2.67	-	16	-	-	-	M.Dense	21	0	0	55	10	14	-	-	SM
0.90 to 3.50	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	19.9	-	-	-	V.Dense	41	15	26	12	6	0	2.40	41.90	SDR
3.50 to 4.50	>100	SS	Soft Rock	-	-	-	-	-	2.63	-	20.4	-	-	-	V.Dense	100	0	0	0	0	0	-	42.50	-

Table 2.4: Laboratory Test Result on the Soil Sample Collected from BH-04

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.30	-	DS	Silty Sandy Gravels	-	-	-	-	-	2.66	-	19	-	-	-	Dense	53	0	11	26	10	0	-	-	GP
0.30 to 2.00	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	20.3	-	-	-	V.Dense	37	18	13	19	13	0	5.20	41.80	SDR
2.00 to 3.00	>100	SS	Soft Rock	-	-	-	-	-	2.63	-	21.1	-	-	-	V.Dense	100	0	0	0	0	0	-	42.20	SR

Table 2.5: Laboratory Test Result on the Soil Sample Collected from BH-05

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.50	-	DS	Soft Disintegrated Rock	-	-	-	-	-	2.66	-	19.3	-	-	-	Dense	31	24	9	21	15	0	-	-	SDR
0.50 to 2.50	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	20.4	-	-	-	V.Dense	47	19	18	13	3	0	1.20	42.20	SDR

Table 2.6: Laboratory Test Result on the Soil Sample Collected from BH-06

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.40	-	DS	Soft Disintegrated Rock	-	-	-	-	-	2.66	-	19.6	-	-	-	Dense	24	21	18	28	9	0	-	-	SDR
0.40 to 3.00	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	20.4	-	-	-	V.Dense	48	12	13	19	8	0	3.20	42.30	SDR

Table 2.7: Laboratory Test Result on the Soil Sample Collected from BH-07

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.50	-	DS	Soft Disintegrated Rock	-	-	-	-	-	2.66	-	19.4	-	-	-	Dense	30	14	11	39	6	0	-	-	SDR
0.50 to 2.50	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	20.6	-	-	-	V.Dense	47	13	20	16	4	0	1.60	42.20	SDR

Table 2.8: Laboratory Test Result on the Soil Sample Collected from BH-08

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.70	-	DS	Silty Sandy Gravels	-	-	-	-	-	2.66	-	19.6	-	-	-	Dense	61	0	10	22	7	0	-	-	GP
0.70 to 3.00	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	21.3	-	-	-	V.Dense	41	16	16	21	6	0	2.40	42.50	SDR

Table 2.9: Laboratory Test Result on the Soil Sample Collected from BH-09

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.60	-	DS	Silty Clay	37	88	21	67	0.8	2.68	1.0	14	-	80	-	Soft	0	0	0	0	14	86	-	-	CH
0.60 to 0.90	-	DS	Silty Clayey Fine Sand mixed with Kankars	-	-	-	-	-	2.66	-	19.5	-	-	-	Dense	22	0	0	51	12	15	-	-	SM
0.90 to 3.00	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	20.4	-	-	-	V.Dense	37	13	19	22	9	0	3.60	42.10	SDR

Table 2.10: Laboratory Test Result on the Soil Sample Collected from BH-10

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.80	-	DS	Silty Sandy Gravels	-	-	-	-	-	2.66	-	19.1	-	-	-	Dense	59	0	11	25	5	0	-	-	GP
0.80 to 3.60	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	20.4	-	-	-	V.Dense	42	12	15	23	8	0	3.20	42.30	SDR

Table 2.11: Laboratory Test Result on the Soil Sample Collected from BH-11

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.50	-	DS	Silty Sandy Gravels	-	-	-	-	-	2.66	-	19.7	-	-	-	Dense	56	0	13	22	9	0	-	-	GP
0.50 to 3.00	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	20.4	-	-	-	V.Dense	44	17	16	21	2	0	0.80	42.20	SDR

Table 2.12: Laboratory Test Result on the Soil Sample Collected from BH-12

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.60	-	DS	Silty Clay	48	89	21	68	0.6	2.68	1.3	14	-	80	-	Soft	0	0	0	0	15	85	-	-	CH
0.60 to 1.60	57	SS	Silty Clayey Fine Sand mixed with Lime Nodules	-	-	-	-	-	2.65	-	20.3	-	-	-	Dense	19	0	0	56	10	15	10.00	42.05	SM
1.60 to 3.00	>100	SS	Weathered Rock	-	-	-	-	-	2.64	-	21.1	-	-	-	V.Dense	34	14	21	20	11	0	4.40	42.20	SDR

Table 2.13: Laboratory Test Result on the Soil Sample Collected from BH-13

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 1.40	9	SS	Silty Clay	29	80	16	64	0.8	2.67	0.8	17	-	80	-	Stiff	0	0	0	0	20	80	60.00	8.00	CH
1.40 to 2.80	73	SS	Silty Fine Sand mixed with kankars	-	-	-	-	-	2.65	-	20.3	-	-	-	V.Dense	28	0	0	58	14	0	5.60	42.00	SM
2.80 to 4.00	>100	SS	Weathered Rock	-	-	-	-	-	2.63	-	21.1	-	-	-	V.Dense	39	11	16	28	6	0	2.40	42.30	SDR

Table 2.14: Laboratory Test Result on the Soil Sample Collected from BH-14

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.40	-	DS	Filled Up Soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.40 to 0.90	-	DS	Silty Clay mixed with lime	41	90	16	74	0.7	2.68	1.1	13	-	85	-	Soft	22	0	0	0	11	67	-	-	CH
0.90 to 3.50	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	21.1	-	-	-	V.Dense	45	19	11	17	8	0	3.20	42.50	SDR

Table 2.15: Laboratory Test Result on the Soil Sample Collected from BH-15

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Clay				Specific Gravity, G	Void Ratio, e	Bulk Density, kN/m^3	Dry Density, kN/m^3	Free Swell (%)	Swelling Pressure (kPa)	Relative Density/ Consistency	Sieve Analysis						Direct Shear		IS-Classification
					LL (%)	PL (%)	PI	Consistency, I_C								Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	c (kN/m^2)	ϕ (Deg.)	
0.00 to 0.30	-	DS	Silty Sandy Gravels	-	-	-	-	-	2.66	-	19.1	-	-	-	Dense	61	0	10	25	4	0	-	-	GP
0.30 to 2.50	>100	SS	Weathered Rock	-	-	-	-	-	2.65	-	20.5	-	-	-	V.Dense	41	15	17	24	3	0	1.20	42.50	SDR

Table 2.16: Chemical Analysis Results conducted on Water/Soil Samples collected from BH-01 to BH-15				
Location	**Depth of Sample below E.G.L. (m)**	**pH**	**Chlorides (ppm)**	**Sulphates (ppm)**
BH-01	3.00	7.71	299.19	336.58
BH-02	3.00	7.71	303.64	341.59
BH-03	3.00	7.71	308.41	346.96
BH-04	3.00	7.71	305.47	343.65
BH-05	3.00	7.71	299.11	336.49
BH-06	3.00	7.71	296.18	333.20
BH-07	3.00	7.71	301.24	338.89
BH-08	3.00	7.71	295.33	332.24
BH-09	3.00	7.71	286.44	322.24
BH-10	3.00	7.71	285.61	321.31
BH-11	3.00	7.71	291.55	327.99
BH-12	3.00	7.71	311.28	350.19
BH-13	1.40	7.71	296.18	333.20
BH-14	3.00	7.71	311.47	350.40
BH-15	3.00	7.71	315.68	355.14

CHAPTER-3

SUB-SURFACE STRATIFICATION

3.0 Preamble

The sub surface stratification at borehole locations, with respect to foundation/geotechnical engineering application are derived based on the visual identification, laboratory classification tests and field in-situ strength tests. Further, the strength parameters are estimated based on the in-situ strength test results as per the following correlation.

* **For Coarse Grained Samples, Ref. Fig.1, IS: 6403 to estimate Angle of Shearing Resistance.**
* **For Fine Grained Samples, Ref. Terzaghi & Peck, 1948, to estimate Unconfined Compressive Strength.**

3.1 Sub Surface Stratification:

3.1.1 Soil Profile at BH-01 Location

(At BH-01 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.50m depth)**

Type of Strata	Soft Disintegrated Rock
Colour	-
Thickness of Layer	0.50m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-2 (from 0.50m to 3.00m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.50m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.2 Soil Profile at BH-02 Location
(At BH-02 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 1.95m depth)**

Type of Strata	Soft Disintegrated Rock
Colour	-
Thickness of Layer	0.70m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-2 (from 0.70m to 3.50m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.80m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.3 Soil Profile at BH-03 Location
(At BH-03 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.50m depth)**

Type of Strata	Silty Sandy Clay
Colour	Brownish
Thickness of Layer	0.50m
SPT of the layer	-
Consistency	Soft
Un-drained Cohesion, Cu	-

* **Layer-2 (from 0.50m to 0.90m depth)**

Type of Strata	Silty Clayey Fine Sand mixed with lime
Colour	Greyish to Whitish
Thickness of Layer	0.40m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-3 (from 0.90m to 3.50m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.60m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50^0

* **Layer-4 (from 3.50m to 4.50m depth)**

Type of Strata	Soft Rock
Colour	-
Thickness of Layer	1.00m
SPT of the layer	>100

Relative Density Very Dense
Angle of Shearing Resistance, 42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.4 Soil Profile at BH-04 Location
(At BH-04 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.30m depth)**

Type of Strata Silty Sandy Gravels
Colour Brownish to Reddish
Thickness of Layer 0.30m
SPT of the layer -
Relative Density Dense
Angle of Shearing Resistance, -

* **Layer-2 (from 0.30m to 2.00m depth)**

Type of Strata Weathered Rock
Colour -
Thickness of Layer 1.70m
SPT of the layer >100
Relative Density Very Dense
Angle of Shearing Resistance, 42.50^0

* **Layer-3 (from 2.00m to 3.00m depth)**

Type of Strata Soft Rock
Colour -
Thickness of Layer 1.00m
SPT of the layer >100
Relative Density Very Dense
Angle of Shearing Resistance, 42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.5 Soil Profile at BH-05 Location
(At BH-05 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.50m depth)**

Type of Strata Soft Disintegrated Rock
Colour -
Thickness of Layer 0.50m
SPT of the layer -
Relative Density Dense
Angle of Shearing Resistance, -

* **Layer-2 (from 0.50m to 2.50m depth)**

Type of Strata Weathered Rock
Colour -
Thickness of Layer 2.00m
SPT of the layer >100

Relative Density Very Dense
Angle of Shearing Resistance, 42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the first week of September 2018.

3.1.6 Soil Profile at BH-06 Location
(At BH-06 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.40m depth)**

Type of Strata Soft Disintegrated Rock
Colour -
Thickness of Layer 0.40m
SPT of the layer -
Relative Density Dense
Angle of Shearing Resistance, -

* **Layer-2 (from 0.40m to 2.80m depth)**

Type of Strata Weathered Rock
Colour -
Thickness of Layer 2.40m
SPT of the layer >100
Relative Density Very Dense
Angle of Shearing Resistance, 42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the first week of September 2018.

3.1.7 Soil Profile at BH-07 Location
(At BH-07 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.50m depth)**

Type of Strata Soft Disintegrated Rock
Colour -
Thickness of Layer 0.50m
SPT of the layer -
Relative Density Dense
Angle of Shearing Resistance, -

* **Layer-2 (from 0.50m to 2.50m depth)**

Type of Strata Weathered Rock
Colour -
Thickness of Layer 2.00m
SPT of the layer >100
Relative Density Very Dense
Angle of Shearing Resistance, 42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the first week of September 2018.

3.1.8 Soil Profile at BH-08 Location
(At BH-08 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.70m depth)**

Type of Strata	Silty Sandy Gravels
Colour	Brownish
Thickness of Layer	0.70m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-2 (from 0.70m to 3.00m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.30m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.9 Soil Profile at BH-09 Location
(At BH-09 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.60m depth)**

Type of Strata	Silty Clay
Colour	Brownish to Greyish
Thickness of Layer	0.60m
SPT of the layer	-
Consistency	Soft
Un-drained Cohesion, Cu	-

* **Layer-2 (from 0.60m to 0.90m depth)**

Type of Strata	Silty Clayey Fine Sand mixed with kankars
Colour	Greyish to Whitish
Thickness of Layer	0.30m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-3 (from 0.90m to 3.00m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.10m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.10 Soil Profile at BH-10 Location
(At BH-10 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.80m depth)**

Type of Strata	Silty Sandy Gravels
Colour	Brownish to Reddish
Thickness of Layer	0.80m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-2 (from 0.80m to 3.60m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.80m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.11 Soil Profile at BH-11 Location
(At BH-11 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.50m depth)**

Type of Strata	Silty Sandy Gravels
Colour	Brownish to Reddish
Thickness of Layer	0.50m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-2 (from 0.50m to 3.00m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.50m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.12 Soil Profile at BH-12 Location
(At BH-12 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.60m depth)**

Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	0.60m
SPT of the layer	-
Consistency	Soft
Un-drained Cohesion, Cu	-

* **Layer-2 (from 0.60m to 1.60m depth)**

Type of Strata	Silty Clayey Fine Sand mixed with lime nodules
Colour	Brownish to Greyish
Thickness of Layer	1.00m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-3 (from 1.60m to 3.00m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	1.40m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50^0

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.13 Soil Profile at BH-13 Location
(At BH-13 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 1.40m depth)**

Type of Strata	Silty Clay
Colour	Brownish to Greyish
Thickness of Layer	1.40m
SPT of the layer	09
Consistency	Stiff
Un-drained Cohesion, Cu	60.00kPa

* **Layer-2 (from 1.40m to 2.80m depth)**

Type of Strata	Silty Fine Sand mixed with Kankars
Colour	Greyish to Whitish
Thickness of Layer	1.40m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-3 (from 2.80m to 4.00m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	1.20m

SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50

Ground Water

Ground water table was encountered at a depth of 1.40m below the existing ground level during the second week of September 2018.

3.1.14 Soil Profile at BH-14 Location
(At BH-14 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.40m depth)**

Type of Strata	Filled Up Soil
Colour	-
Thickness of Layer	0.40m

* **Layer-2 (from 0.40m to 0.90m depth)**

Type of Strata	Silty Clay mixed with lime
Colour	Brownish to Greyish
Thickness of Layer	0.50m
SPT of the layer	-
Consistency	Soft
Un-drained Cohesion, Cu	-

* **Layer-3 (from 0.90m to 3.50m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.60m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

3.1.15 Soil Profile at BH-15 Location
(At BH-15 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.30m depth)**

Type of Strata	Silty Sandy Gravels
Colour	Brownish to Reddish
Thickness of Layer	0.30m
SPT of the layer	-
Relative Density	Dense
Angle of Shearing Resistance,	-

* **Layer-2 (from 0.30m to 2.50m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.20m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance,	42.50

Ground Water

No ground water table was encountered within the explored depth of investigation in the second week of September 2018.

Table 4.0-Safe Bearing Capacities of Open Foundation System located at different depths below present existing ground level at different investigation Locations

Borehole No	Type of Bearing Strata	Depth of Open Excavations below Existing Ground Level (m)	Recommended Thickness of CNS Back-Fill (m)	Depth of Isolated Column Footing below Existing Ground Level (m)	Safe Bearing Capacity (t/m^2)	Elastic Settlements (mm)
BH-01	Weathered Rock	2.00	0.00	2.00	30	15
BH-02	Weathered Rock	2.00	0.00	2.00	30	15
BH-03	Weathered Rock	2.00	0.00	2.00	30	15
BH-04	Soft Rock	2.00	0.00	2.00	40	15
BH-05	Weathered Rock	2.00	0.00	2.00	30	15
BH-06	Weathered Rock	2.00	0.00	2.00	30	15
BH-07	Weathered Rock	2.00	0.00	2.00	30	15
BH-08	Weathered Rock	2.00	0.00	2.00	30	15
BH-09	Weathered Rock	2.00	0.00	2.00	30	15
BH-10	Weathered Rock	2.00	0.00	2.00	30	15
BH-11	Weathered Rock	2.00	0.00	2.00	30	15
BH-12	Weathered Rock	2.00	0.00	2.00	30	15
BH-13	Silty Fine Sand	2.00	0.00	2.00	30	15
BH-14	Weathered Rock	2.00	0.00	2.00	30	25
BH-15	Weathered Rock	2.00	0.00	2.00	30	25

Notes

1.Settlements are restricted to a maximum of 25mm for Isolated Column Footings.

2. Excavated highly plastic fine-grained soil encountered at shallow depths shall be in no case used for back filling purposes (Ref. BH-13 & BH-14).

3. It is recommended to connect the grade beams for the entire structure to act as a single unit against any differential settlements in between the individual footings.

4. No structural units can be in direct contact of highly plastic fine-grained soil encountered at isolated borehole locations. A 0.30m thick well compacted CNS (cohesive non-swelling) soil cushion is recommended to be sand-witched in between.

5. CNS can be clean river sand or M-Sand or Sand-Gravels mix of 1:2.

CHAPTER-5

CONCLUSIONS & RECOMMENDATIONS

1. Open Foundation system presented in Table 4.0, Page No. 45 & 46 can be adopted for foundation design purposes.

Open Foundation System

2. Safe bearing capacity of open foundation system is computed considering any rise in the ground water table up to or above the level of footing.
3. In case, ground water table is encountered within recommended depth of foundation system, provision shall be made to continuously bail the water out of the foundation pits to keep the surfaces of pit consolidated dry.

Usage of Excavated Earth

4. **Excavated highly plastic fine-grained soil encountered at shallow depths shall be in no case used for back filling purposes (Ref. BH-13 & BH-14).**
5. **No structural units can be in direct contact of medium plastic fine-grained soil strata encountered at shallow depths. A 0.30m thick well compacted CNS (cohesive non-swelling) soil cushion is recommended to be sand-witched in between.**

Type of CNS to Use

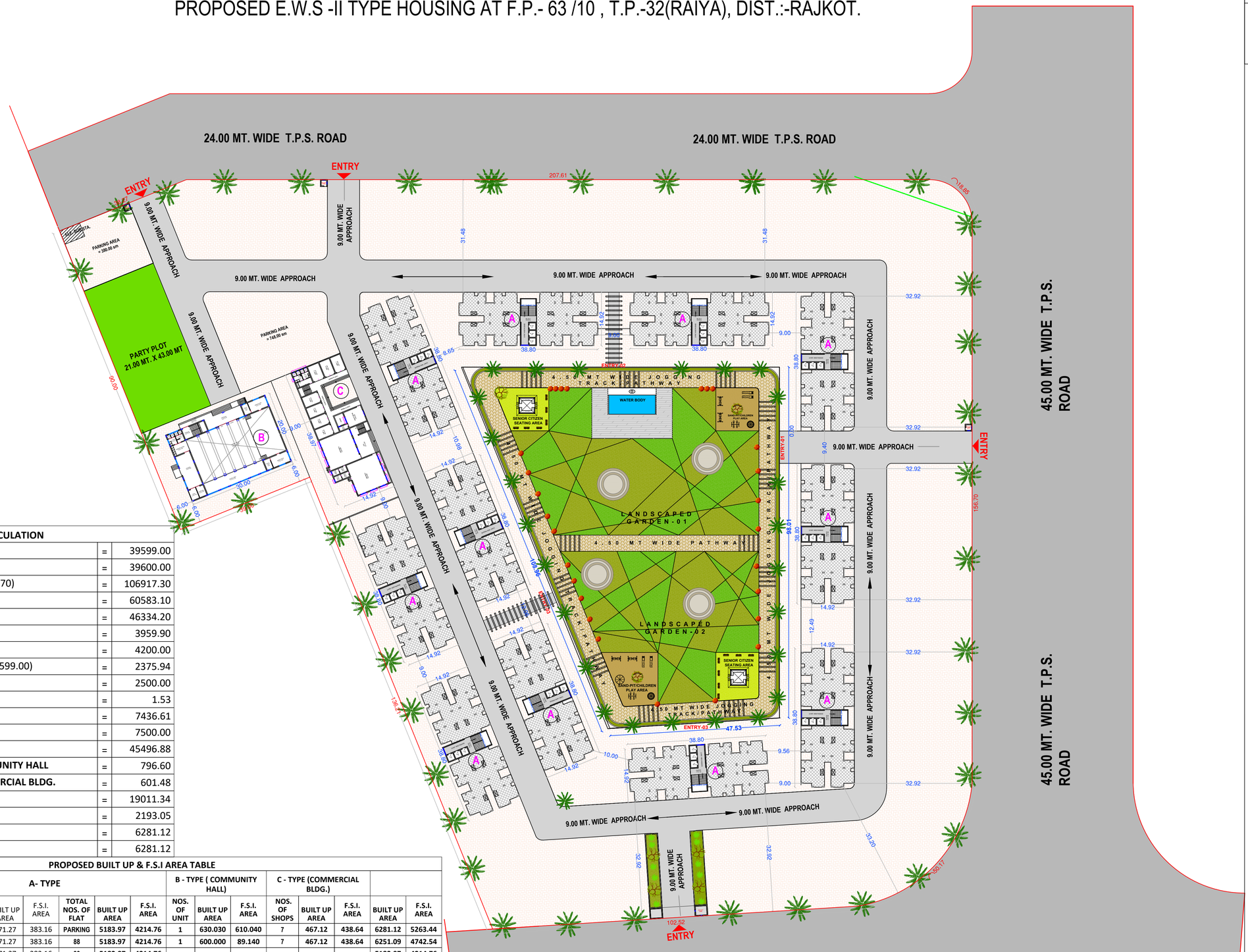
6. **CNS can be well graded coarse-grained M-Sand or quarry dust or clean river sand or sand: gravels mix (1:2) or fly-ash.**

Other Recommendations

7. It is recommended to connect the grade beams for the entire structure to act as a single unit against any differential settlements in between the individual footings.
8. As the chlorides and sulphates present in water/soil samples are within the permissible limits, no special steel or cement is recommended to be used for foundation construction purposes.

2.1.4 Layout Plan

PROPOSED E.W.S -II TYPE HOUSING AT F.P.- 63 /10 , T.P.-32(RAIYA), DIST.:-RAJKOT.



AREA CALCULATION

PLOT AREA	=	39599.00
NET PLOT AREA	=	39600.00
PERMISSIBLE F.S.I. AREA (39599.00 X 2.70)	=	106917.30
PROPOSED F.S.I. AREA	=	60583.10
BLANCE F.S.I. AREA	=	46334.20
REQUIRED C.P. AREA (10 % X39599.00)	=	3959.90
PROPOSED C.P. AREA	=	4200.00
REQUIRED GREEN BELT AREA (6 % X 39599.00)	=	2375.94
PROPOSED GREEN BELT AREA	=	2500.00
F.S.I. CONSUME	=	1.53
REQUIRED PARKING AREA	=	7436.61
PROPOSED PARKING AREA	=	7500.00
TOTAL CARRET AREA (A-TYPE)	=	45496.88
TOTAL CARRET AREA (B-TYPE) COMMUNITY HALL	=	796.60
TOTAL CARRET AREA (C-TYPE) COMMERCIAL BLDG.	=	601.48
TOTAL OPEN AREA	=	19011.34
TOTAL BALCONY AREA (A-TYPE)	=	2193.05
TOTAL COVERED AREA	=	6281.12
TOTAL GROUND COVERED AREA	=	6281.12

PROPOSED BUILT UP & F.S.I AREA TABLE

FLOOR		A- TYPE							B - TYPE (COMMUNITY HALL)			C - TYPE (COMMERCIAL BLDG.)				
	USE	NOS. OF UNIT	NOS. OF FLAT	BUILT UP AREA	F.S.I. AREA	TOTAL NOS. OF FLAT	BUILT UP AREA	F.S.I. AREA	NOS. OF UNIT	BUILT UP AREA	F.S.I. AREA	NOS. OF SHOPS	BUILT UP AREA	F.S.I. AREA	BUILT UP AREA	F.S.I. AREA
GR. FL.	RESI.	11	PARKING	471.27	383.16	PARKING	5183.97	4214.76	1	630.030	610.040	7	467.12	438.64	6281.12	5263.44
1ST FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	1	600.000	89.140	7	467.12	438.64	6251.09	4742.54
2nd FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
3rd FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
4th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
5th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
6th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
7th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
8th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
9th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
10th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
11th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
12th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
13th FL.	RESI.	11	8	471.27	383.16	88	5183.97	4214.76	----	----	----	----	----	----	5183.97	4214.76
STAIRCABIN		11	---	76.48	----	---	841.28	----	1	24.65	----	---	31.53	----	897.46	---
LMR & O.H.WT.		11	---	71.91	----	---	791.01	----	1	16.12	----	---	20.98	----	828.11	---
TOTAL			104	6746.170	5364.240	1144	74207.87	59006.64	1	1270.800	699.18	14 SHOPS	986.75	877.28	76465.42	60583.10

GROUND FL. LAYOUT PLAN

FOR DPR PURPOSE

LAYOUT PLAN

A - TYPE .....11.BLDG.....PARKING + 13FL.

TOTAL NO. OF UNIT'S = 1144

CARPET AREA = 39.77 SM.

REVISION :	DATE :
SCALE : N.T.S	TYPE :

LAY OUT PLAN

CLIENT: RAJKOT MUNICIPAL CORPORATION

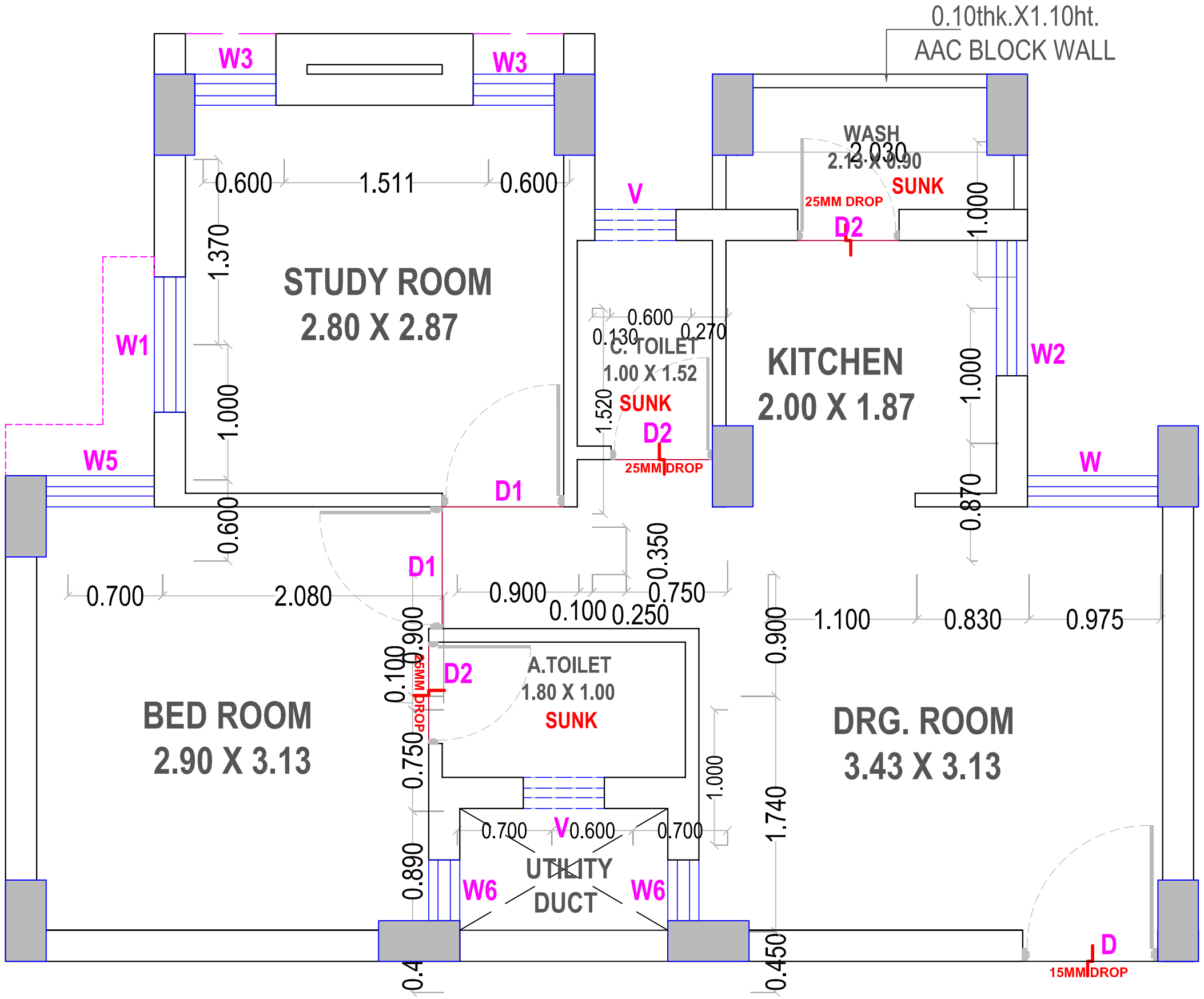
PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.

JAYESSH A DALAL
PROJECT MANAGEMENT CONSULTANT
"JALARAM SHAKTI", BESIDE DHANALGIRI APARTMENT, NR.LOURD'S CONVENT SCHOOL,ATHWALINES,SURAT.

DRAWN BY	CHECK BY		SHEET NO	28Y 19
			A-001	

2.1.5 Unit Plan

PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.



FOR DPR PURPOSE

UNIT PLAN

CARPET AREA = 39.36 SQ.MTS

BUILT UP AREA = 47.72 SQ.MTS

271

REVISION :	DATE :
SCALE : N.T.S	TYPE : A - TYPE

WORKING DRAWING

CLIENT: RAJKOT MUNICIPAL CORPORATION

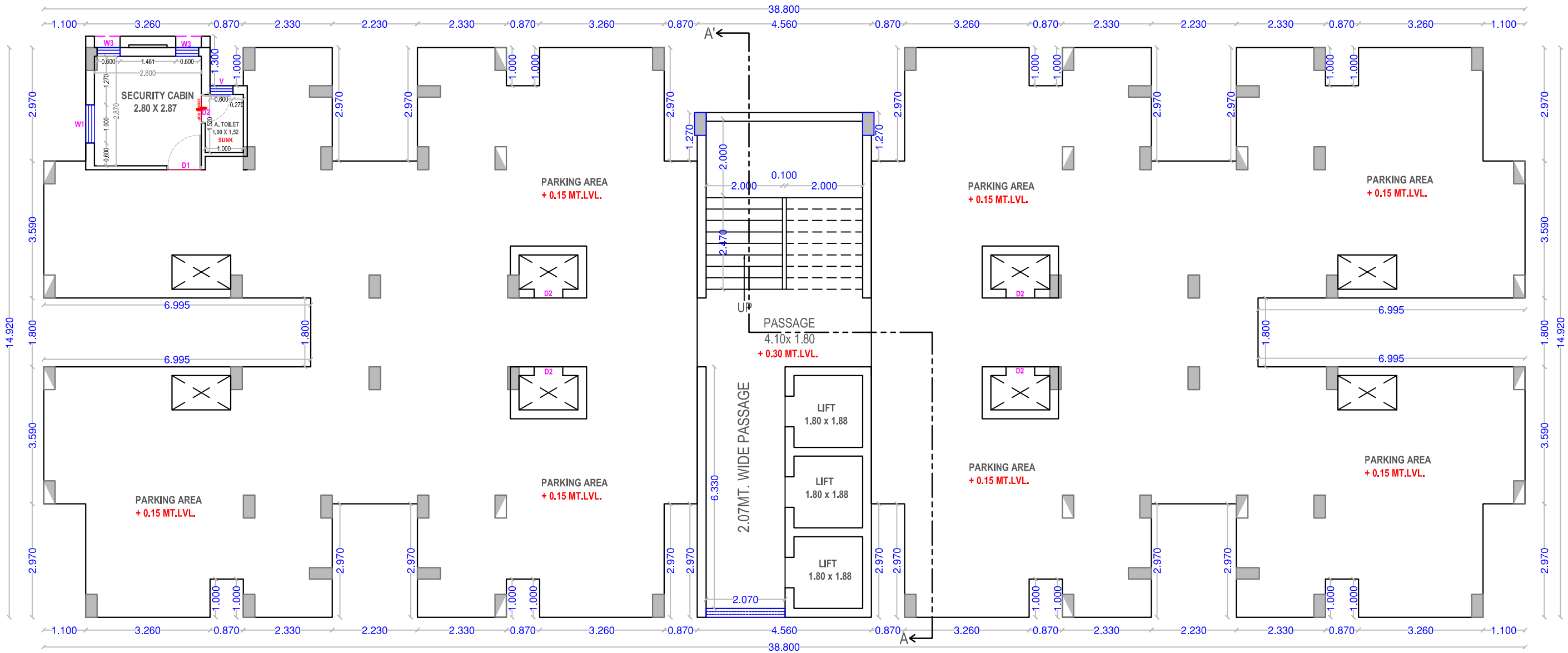
PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.

JAYESSH A DALAL
PROJECT MANAGEMENT CONSULTANT
"JALARAM SHAKTI", BESIDE DHAWALGIRI APARTMENT, NR.LOURD'S CONVENT SCHOOL,ATHWALINES,SURAT.

DRAWN BY	CHECK BY		SHEET NO
SAGUNA			28Y 19

2.1.6 Floor Plans

PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.



GROUND FLOOR PLAN

(PARKING + 13th.FL.)

FOR DPR PURPOSE

WORKING DRAWING

BLDG.PLAN GR+13FL.

A -TYPE ...(11.BLDG.)

GROUND FLOOR PLAN

SCHEDULE OF DOORS

SR.NO.	NAME	SIZE (OPENING)	POSITION	GR. FL	TY. FL x 13TH FL.	TERR.FL	SILL.	LINTEL.	TOTAL GR.+TYP+TER.=
1.	D	1.000 X 2.425	DRG.RM.	0	8 x 13	2	-	2.425	0 + 104 + 2 = 106
2.	D1	0.900 X 2.425	BED ROOM	1	16 x 13	-	-	2.425	1 + 208 + 0 = 209
3.	D2	0.750 X 2.425	C.TOILET,A.TOILET WASH,	5	24 x 13	-	-	2.425	5 + 312 + 0= 317

SCHEDULE OF WINDOW

SR.NO.	NAME	SIZE (OPENING)	POSITION	GR. FL	TY. FL x 13TH FL.	TERR.FL	SILL.	LINTEL.	TOTAL GR.+TYP+TER.=
1.	W	0.965 X 1.525	DRG. ROOM	0	8 x 13	-	0.900	2.425	0 + 104 + 0 = 104
2.	W1	1.000 X 1.525	STUDY ROOM	1	8 x 13	-	0.900	2.425	1 + 104 + 0 = 105
3.	W2	1.000 X 1.225	KITCHEN	0	8 x 13	-	1.200	2.425	0 + 104 + 0 = 104
4.	W3	0.600 X 1.525	STUDY ROOM	2	16 x 13	-	0.900	2.425	2 + 208 + 0 = 210
5.	W4	0.870 X 1.525	BEDROOM	0	4 x 13	-	0.900	2.425	0 + 52 + 0 = 52
6.	W5	0.800 X 1.525	BEDROOM	0	4 x 13	-	0.900	2.425	0 + 52 + 0 = 52
7.	W6	0.450 X 1.525	BEDROOM	0	16 x 13	-	0.900	2.425	0 + 208 + 0 = 208

SCHEDULE OF VENTILATION

SR.NO.	NAME	SIZE (OPENING)	POSITION	GR. FL	TY. FL x 13TH FL.	TERR.FL	SILL.	LINTEL.	TOTAL GR.+TYP+TER.=
1.	V	0.600 X 0.600	C.TOILET,A.TOILET	1	16 x 13	-	-	2.425	1 + 208 + 0 = 209

REVISION :	DATE :
SCALE : N.T.S	TYPE : A - TYPE

WORKING DRAWING

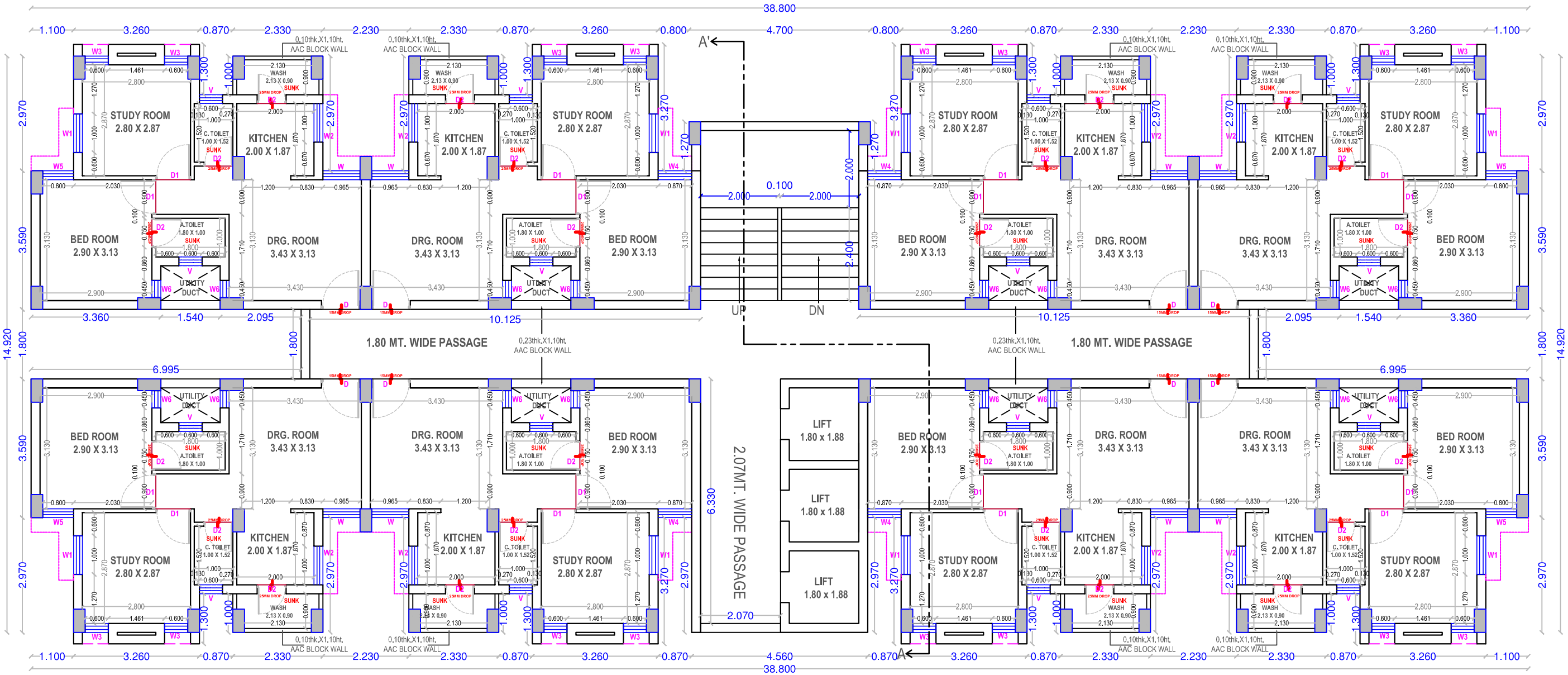
CLIENT: RAJKOT MUNICIPAL CORPORATION

PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.

JAYESSH A DALAL
PROJECT MANAGEMENT CONSULTANT
"JALARAM SHAKTI", BESIDE DHAWALGIRI APARTMENT, NR.LOURD'S CONVENT SCHOOL,ATHWALINES,SURAT.

DRAWN BY	CHECK BY		SHEET NO
SAGUNA			28Y 19

PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.



TYPICAL FLOOR PLAN

(1ST TO 13TH.FL.)

FOR DPR PURPOSE

WORKING DRAWING

BLDG.PLAN GR+13FL.

A -TYPE ...(11.BLDG.)

TYPICAL FLOOR PLAN

SCHEDULE OF DOORS

SR.NO.	NAME	SIZE (OPENING)	POSITION	GR. FL	TY. FL x 13TH FL.	TERR.FL	SILL.	LINTEL.	TOTAL GR.+TYP+TER.=
1.	D	1.000 X 2.425	DRG.RM.	0	8 x 13	2	-	2.425	0 + 104 + 2 = 106
2.	D1	0.900 X 2.425	BED ROOM	1	16 x 13	-	-	2.425	1 + 208 + 0 = 209
3.	D2	0.750 X 2.425	C.TOILET,A.TOILET WASH,	5	24 x 13	-	-	2.425	5 + 312 + 0= 317

SCHEDULE OF WINDOW

1.	W	0.965 X 1.525	DRG. ROOM	0	8 x 13	-	0.900	2.425	0 + 104 + 0 = 104
2.	W1	1.000 X 1.525	STUDY ROOM	1	8 x 13	-	0.900	2.425	1 + 104 + 0 = 105
3.	W2	1.000 X 1.225	KITCHEN	0	8 x 13	-	1.200	2.425	0 + 104 + 0 = 104
4.	W3	0.600 X 1.525	STUDY ROOM	2	16 x 13	-	0.900	2.425	2 + 208 + 0 = 210
5.	W4	0.870 X 1.525	BEDROOM	0	4 x 13	-	0.900	2.425	0 + 52 + 0 = 52
6.	W5	0.800 X 1.525	BEDROOM	0	4 x 13	-	0.900	2.425	0 + 52 + 0 = 52
7.	W6	0.450 X 1.525	BEDROOM	0	16 x 13	-	0.900	2.425	0 + 208 + 0 = 208

SCHEDULE OF VENTILATION

1.	V	0.600 X 0.600	C.TOILET,A.TOILET	1	16 x 13	-	-	2.425	1 + 208 + 0 = 209

REVISION :	DATE :
SCALE : N.T.S	TYPE : A - TYPE

WORKING DRAWING

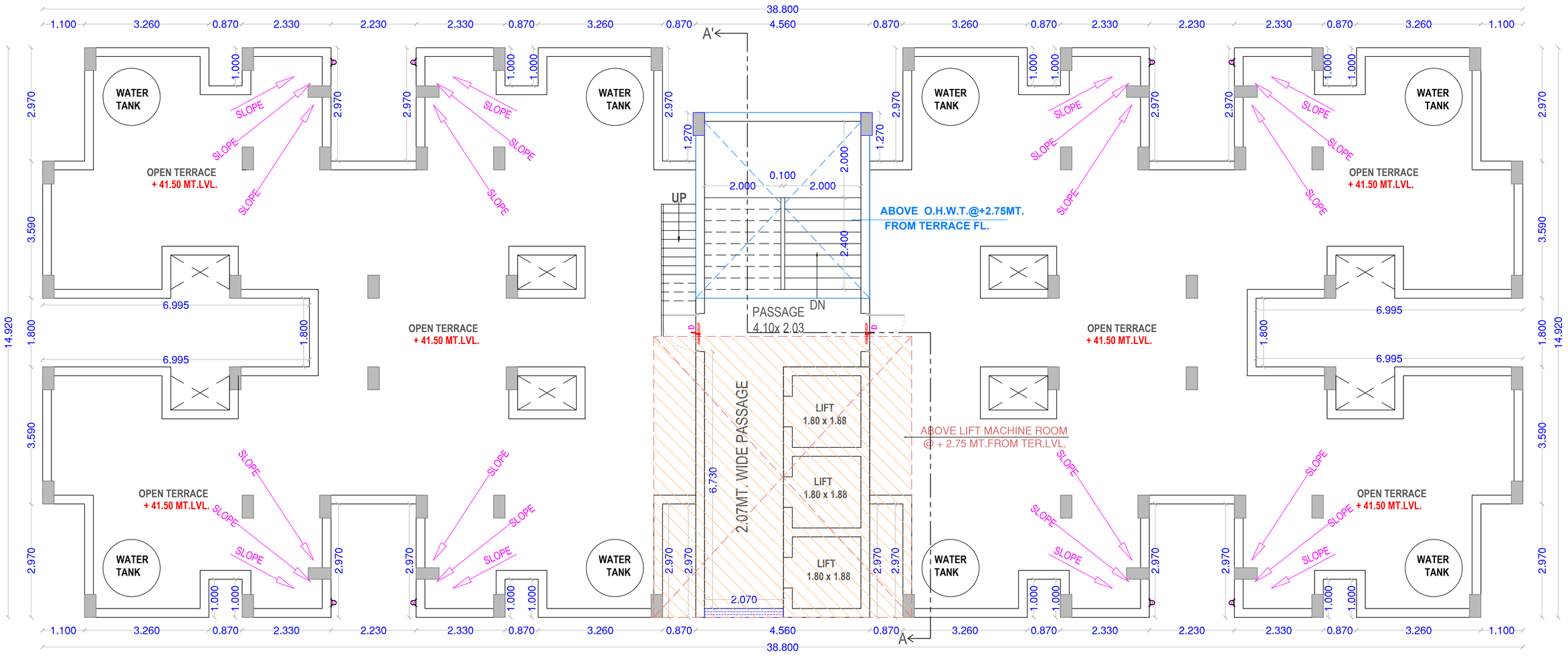
CLIENT: RAJKOT MUNICIPAL CORPORATION

PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.

JAYESSH A DALAL
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"JALARAM SHAKTI", BESIDE DHAWALGIRI APARTMENT, NR.LOURD'S CONVENT SCHOOL,.ATHWALINES,SURAT.

DRAWN BY	CHECK BY		SHEET NO
SAGUNA			28Y 19

PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.



TERRACE FLOOR PLAN

FOR DPR PURPOSE

WORKING DRAWING

BLDG.PLAN GR+13FL.

A -TYPE ...(11.BLDG.)

TERRACE FLOOR PLAN

SCHEDULE OF DOORS

SR.NO.	NAME	SIZE (OPENING)	POSITION	GR. FL	TY. FL x 13TH FL.	TERR.FL	SILL.	LINTEL.	TOTAL GR.+TYP+TER.=
1.	D	1.000 X 2.425	DRG.RM.	0	8 x 13	2	-	2.425	0 + 104 + 2 = 106
2.	D1	0.900 X 2.425	BED ROOM	1	16 x 13	-	-	2.425	1 + 208 + 0 = 209
3.	D2	0.750 X 2.425	C.TOILET,A.TOILET WASH,	5	24 x 13	-	-	2.425	5 + 312 + 0= 317

SCHEDULE OF WINDOW

1.	W	0.965 X 1.525	DRG. ROOM	0	8 x 13	-	0.900	2.425	0 + 104 + 0 = 104
2.	W1	1.000 X 1.525	STUDY ROOM	1	8 x 13	-	0.900	2.425	1 + 104 + 0 = 105
3.	W2	1.000 X 1.225	KITCHEN	0	8 x 13	-	1.200	2.425	0 + 104 + 0 = 104
4.	W3	0.600 X 1.525	STUDY ROOM	2	16 x 13	-	0.900	2.425	2 + 208 + 0 = 210
5.	W4	0.870 X 1.525	BEDROOM	0	4 x 13	-	0.900	2.425	0 + 52 + 0 = 52
6.	W5	0.800 X 1.525	BEDROOM	0	4 x 13	-	0.900	2.425	0 + 52 + 0 = 52
7.	W6	0.450 X 1.525	BEDROOM	0	16 x 13	-	0.900	2.425	0 + 208 + 0 = 208

SCHEDULE OF VENTILATION

1.	V	0.600 X 0.600	C.TOILET,A.TOILET	1	16 x 13	-	-	2.425	1 + 208 + 0 = 209

275

REVISION :	DATE :
SCALE : N.T.S	TYPE : A - TYPE

WORKING DRAWING

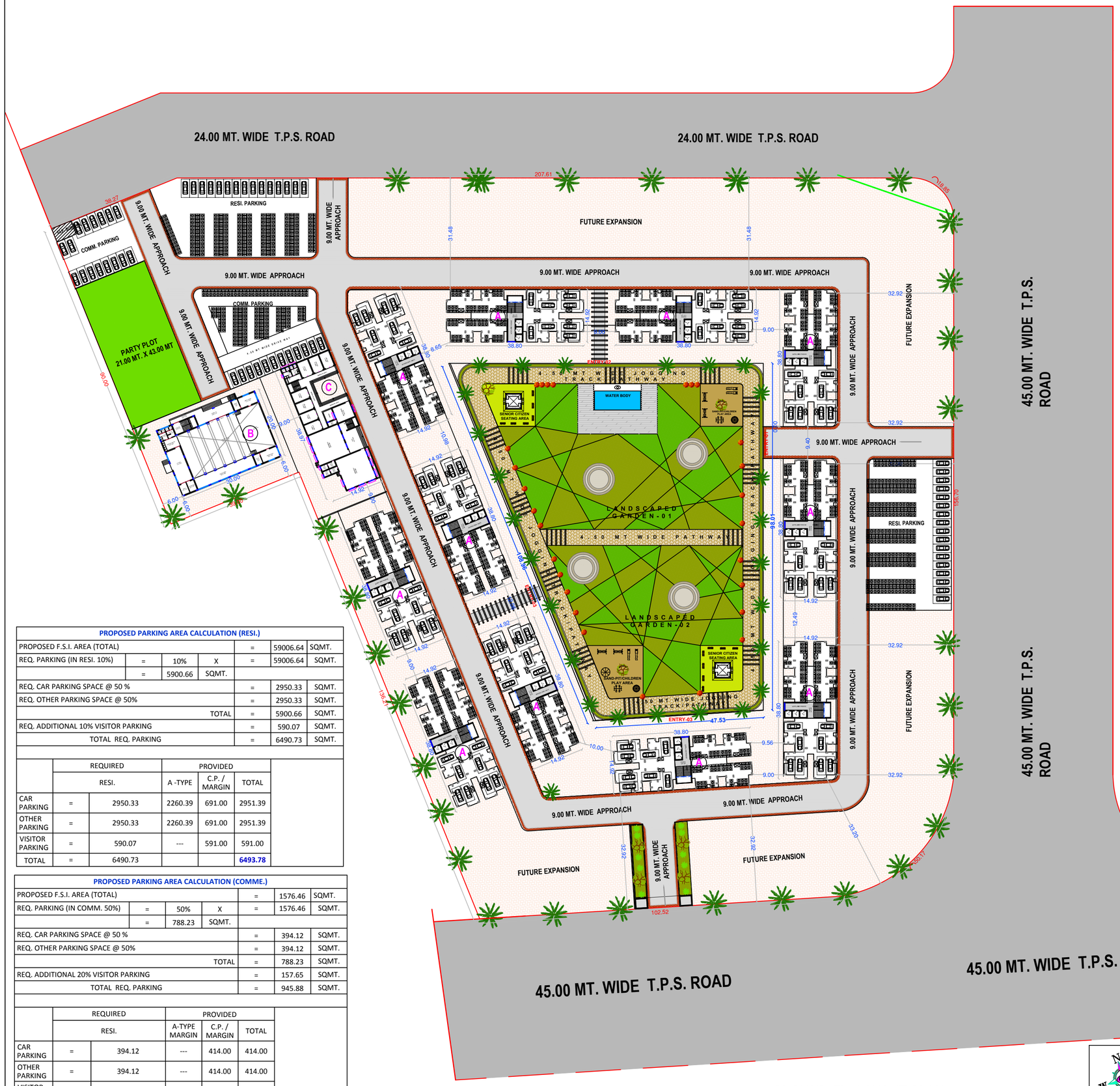
CLIENT: RAJKOT MUNICIPAL CORPORATION

PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.

JAYESSH A DALAL
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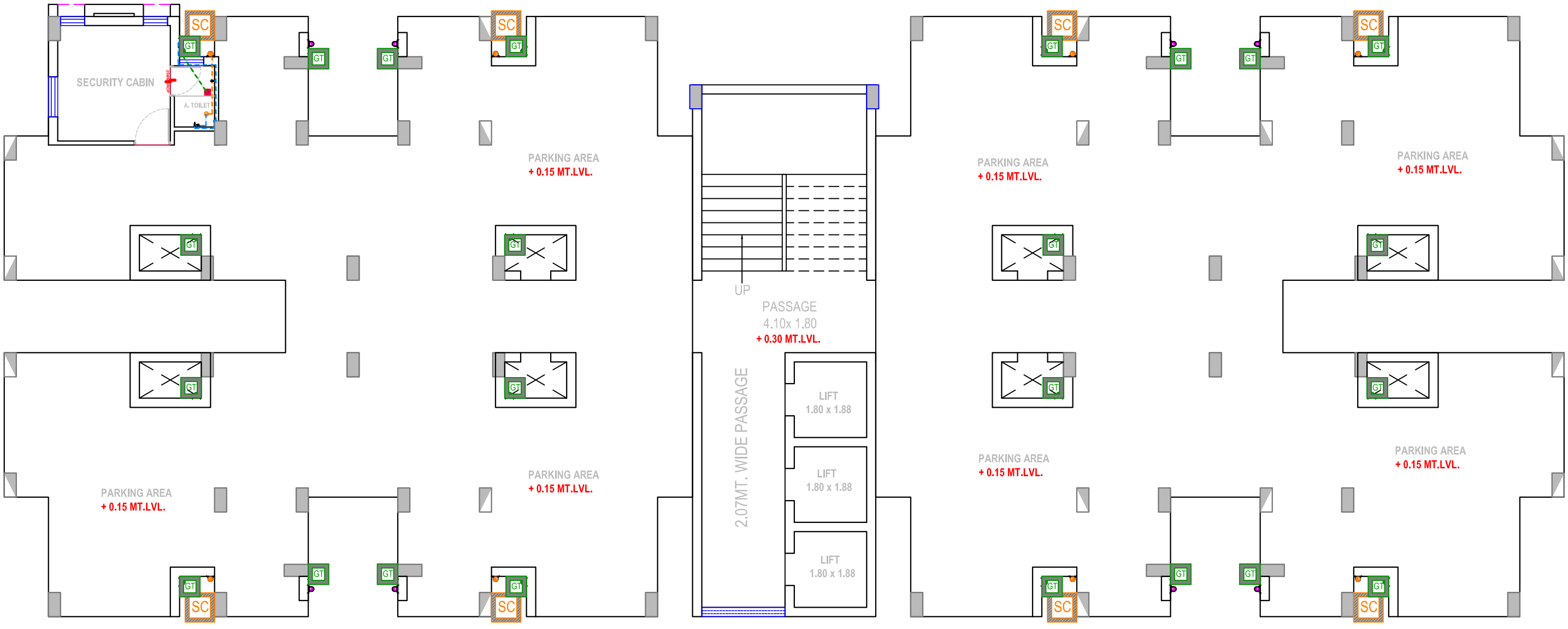
DRAWN BY	CHECK BY		SHEET NO
SAGUNA			28Y 19

PROPOSED E.W.S -II TYPE HOUSING AT F.P.- 63 /10 , T.P.-32(RAIYA), DIST.:-RAJKOT.


24.00 MT. WIDE T.P.S. ROAD
24.00 MT. WIDE T.P.S. ROAD
45.00 MT. WIDE T.P.S. ROAD
45.00 MT. WIDE T.P.S. ROAD
45.00 MT. WIDE T.P.S. ROAD
RESI. PARKING
COMM. PARKING
COMM. PARKING
PARTY PLOT 21.00 MT. X 43.00 MT
FUTURE EXPANSION
FUTURE EXPANSION
FUTURE EXPANSION
FUTURE EXPANSION
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
9.00 MT. WIDE APPROACH
4.50 MT WIDE JOGGING TRACK PATHWAY
WATER BODY
SENIOR CITIZEN SEATING AREA
LANDSCAPED GARDEN-01
4.50 MT WIDE PATHWAY
LANDSCAPED GARDEN-02
SAND-PIT-CHILDREN PLAY AREA
SENIOR CITIZEN SEATING AREA
5.0 MT WIDE JOGGING TRACK/PATHWAY
ENTRY-01
ENTRY-02
A
B
C
207.61
38.37
90.00
31.48
31.48
38.80
38.80
47.53
102.52
32.92
32.92
32.92

2.1.7 Physical Infrastructure Drawings

PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.



278

FOR DPR PURPOSE

PLUMBING DRAWING

BLDG.PLAN GR+13FL.

A -TYPE ...(11.BLDG.)

GRUND FLOOR PLAN

Plumbing legends:-

SR.NO:	SYMBOL	DESCRIPTION
01		EUROPEAN TYPE W.C. PAN
02		WASH BASIN
03		A.C. - Angular cock
04		B.C. - Bib cock
05		2 way (B.C.) Bib cock with H.F.(health fauset)
06		S.C. - Sink cock
07		C.V. - Controlled Valve
08		Soil Water down take
09		Rain Water down take
10		Waste Water down take
11		Domestic Water down take
12		Soil Water Pipe
13		Waste Water Pipe
14		Domestic water supply pipe
15		F.D. - Floor drain " or " N.T. - nahni trap M.F.T. - Multi floor trap

REVISION :	DATE :
SCALE : N.T.S	TYPE : A - TYPE

PLUMBING DRAWING

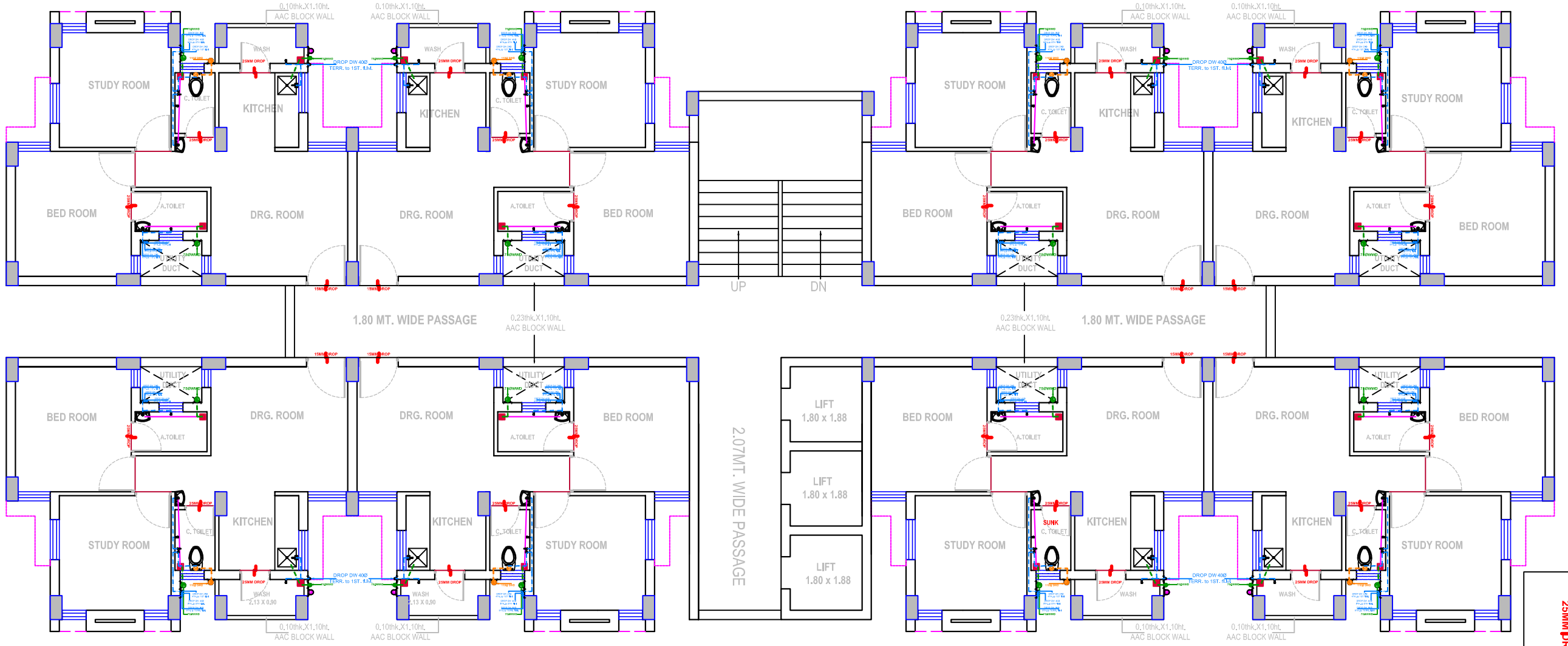
CLIENT: RAJKOT MUNICIPAL CORPORATION

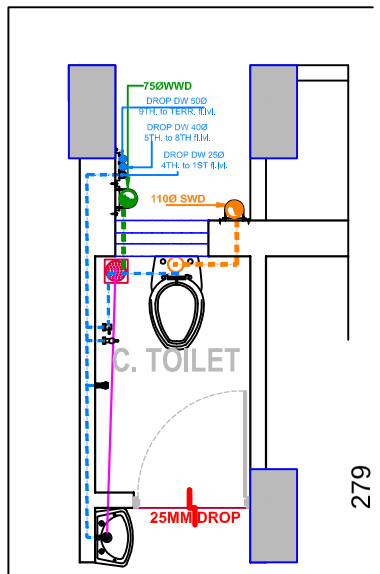
PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.

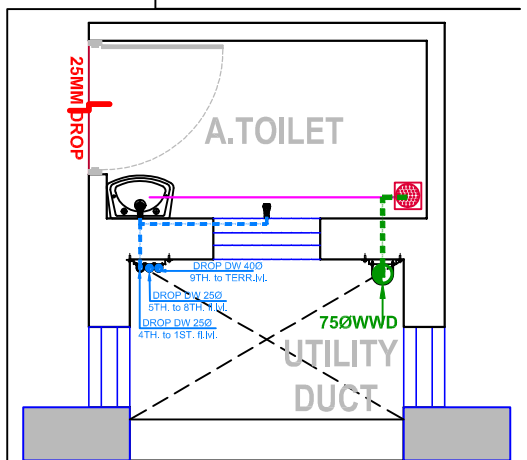
JAYESSH A DALAL
PROJECT MANAGEMENT CONSULTANT
"JALARAM SHAKTI", BESIDE DHAWALGIRI APARTMENT, NR.LOURD'S CONVENT SCHOOL,ATHWALINES,SURAT.

DRAWN BY	CHECK BY		SHEET NO	
SAGUNA			A-PL-02	28Y 19

PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.







TYPICAL FLOOR PLAN

(1ST TO 13TH.FL.)

FOR DPR PURPOSE

PLUMBING DRAWING

BLDG.PLAN GR+13FL.

A -TYPE ...(11.BLDG.)

TYPICAL FLOOR PLAN

Plumbing legends:-

SR.NO:	SYMBOL	DESCRIPTION
01		EUROPEAN TYPE W.C. PAN
02		WASH BASIN
03		A.C. - Angular cock
04		B.C. - Bib cock
05		2 way (B.C.) Bib cock with H.F.(health fauset)
06		S.C. - Sink cock
07		C.V. - Controlled Valve
08		Soil Water down take
09		Rain Water down take
10		Waste Water down take
11		Domestic Water down take
12		Soil Water Pipe
13		Waste Water Pipe
14		Domestic water supply pipe
15		F.D. - Floor drain " or " N.T. - nahni trap M.F.T. - Multi floor trap

REVISION :	DATE :
SCALE : N.T.S	TYPE : A - TYPE

PLUMBING DRAWING

CLIENT: RAJKOT MUNICIPAL CORPORATION

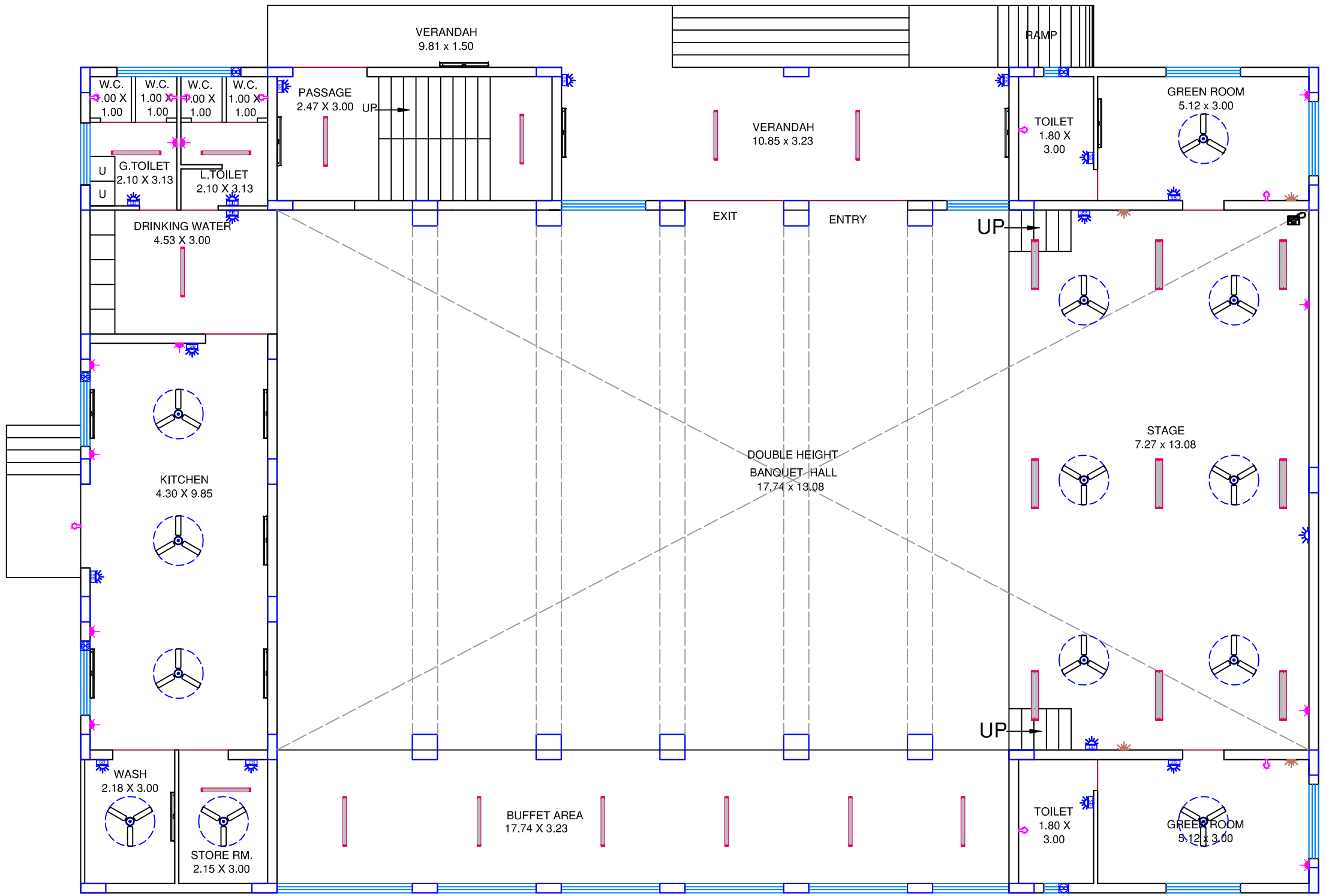
PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.

JAYESSH A DALAL
PROJECT MANAGEMENT CONSULTANT
"JALARAM SHAKTI", BESIDE DHAWALGIRI APARTMENT, NR.LOURD'S CONVENT SCHOOL,ATHWALINES,SURAT.

DRAWN BY	CHECK BY		SHEET NO	
SAGUNA			A-PL-03	28Y 19

2.1.8 Social Infrastructure Building Drawings

PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.



GROUND FLOOR PLAN

FOR DPR PURPOSE

ELECTRICAL DRAWING

BLDG.PLAN GR+1 FL.

COMMERCIAL BLDG.

GROUND FLOOR PLAN

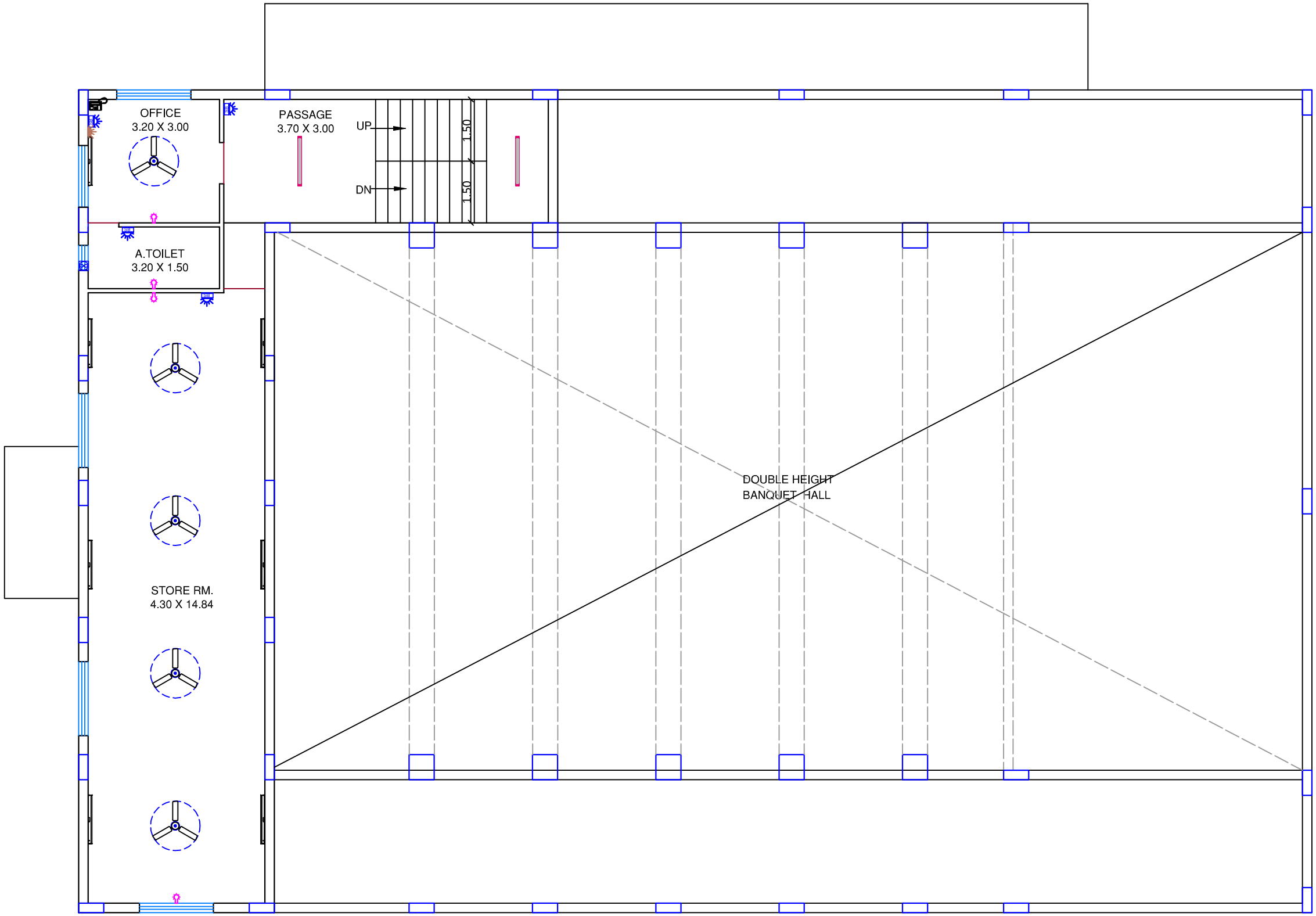
SYMBOL	DESCRIPTION	MOUNTING HEIGHT
	LIGHTING DISTRIBUTION BOARD(LDB) [I/C-25A DP , O/G-20A ,SP-1,16A SP-2,10A SP-3]	1800mm
	6 A /16 A LOOPED PLUG POINT	1200mm
	6A SWITCH SOCKET OUTLET	ON BOARD
	20A PP AC POINT	1200mm
	15A PP SWITCH SOCKET OUTLET	1200mm
	36 Watt Tube Light	2100mm
	36 Watt Tube Light	CEILING
	36 Watt Tube Light	CEILING
	Ceiling Fan	CEILING
	1X18W BRAKET LIGHT	2100mm

REVISION :	DATE :
SCALE : N.T.S	TYPE :
ELECTRICAL DRAWING	
CLIENT: RAJKOT MUNICIPAL CORPORATION	
PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.	

JAYESSH A DALAL
PROJECT MANAGEMENT CONSULTANT
JALARAM SHAKTI, BESIDE DHAWALGIRI APARTMENT, NR.LOURD'S CONVENT SCHOOL,ATHWALINES,SURAT.

DRAWN BY	CHECK BY		SHEET NO	
SAGUNA			A-EL-26	28Y 19

PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.



MEZZ. FLOOR PLAN

FOR DPR PURPOSE

ELECTRICAL DRAWING

BLDG.PLAN GR+1 FL.

COMMERCIAL BLDG.

MEZZANINE FLOOR PLAN

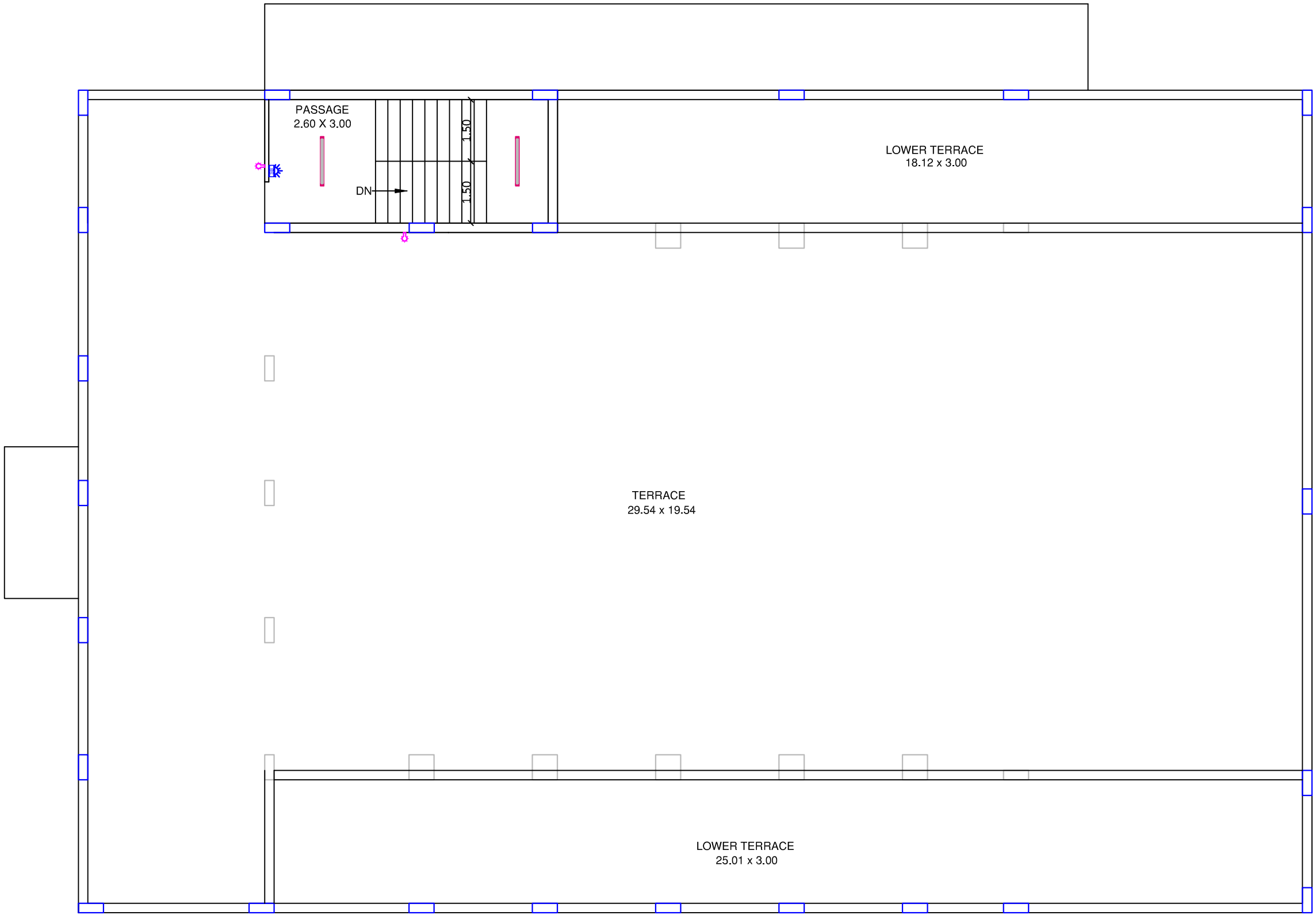
SYMBOL	DESCRIPTION	MOUNTING HEIGHT
	LIGHTING DISTRIBUTION BOARD(LDB) [I/C-25A DP , O/G-20A ,SP-1,16A SP-2,10A SP-3]	1800mm
	6 A /16 A LOOPED PLUG POINT	1200mm
	6A SWITCH SOCKET OUTLET	ON BOARD
	20A PP AC POINT	1200mm
	15A PP SWITCH SOCKET OUTLET	1200mm
	36 Watt Tube Light	2100mm
	36 Watt Tube Light	CEILING
	36 Watt Tube Light	CEILING
	Ceiling Fan	CEILING
	1X18W BRAKET LIGHT	2100mm

REVISION :	DATE :
SCALE : N.T.S	TYPE :
ELECTRICAL DRAWING	
CLIENT: RAJKOT MUNICIPAL CORPORATION	
PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.	

JAYESSH A DALAL
PROJECT MANAGEMENT CONSULTANT
"JALARAM SHAKTI", BESIDE DHAWALGIRI APARTMENT, NR.LOURD'S CONVENT SCHOOL,ATHWALINES,SURAT.

DRAWN BY	CHECK BY		SHEET NO	
SAGUNA			A-EL-27	28Y 19

PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.



TERRACE FLOOR PLAN

FOR DPR PURPOSE

ELECTRICAL DRAWING

BLDG.PLAN GR+1 FL.

COMMERCIAL BLDG.

TERRACE FLOOR PLAN

SYMBOL	DESCRIPTION	MOUNTING HEIGHT
	LIGHTING DISTRIBUTION BOARD(LDB) [I/C-25A DP , O/G-20A ,SP-1,16A SP-2,10A SP-3]	1800mm
	6 A /16 A LOOPED PLUG POINT	1200mm
	6A SWITCH SOCKET OUTLET	ON BOARD
	20A PP AC POINT	1200mm
	15A PP SWITCH SOCKET OUTLET	1200mm
	36 Watt Tube Light	2100mm
	36 Watt Tube Light	CEILING
	36 Watt Tube Light	CEILING
	Ceiling Fan	CEILING
	1X18W BRAKET LIGHT	2100mm

REVISION :	DATE :
SCALE : N.T.S	TYPE :

ELECTRICAL DRAWING

CLIENT: RAJKOT MUNICIPAL CORPORATION

PROJECT: PROPOSED E.W.S -II TYPE HOUSING AT F.P.-63/10 , T.P.-32(RAIYA), DIST.:-RAJKOT.

JAYESSH A DALAL
PROJECT MANAGEMENT CONSULTANT
"JALARAM SHAKTI", BESIDE DHAWALGIRI APARTMENT, INFLOURD'S CONVENT SCHOOL,ATHWALINES,SURAT.

DRAWN BY	CHECK BY		SHEET NO	
SAGUNA			A-EL-28	28Y 19

283

2.2 LHP 2 Jharkhand

2.2.1 Location Map

Site Name	Land Details	Area in Acres
Bajra 485	Mauja – Bajra , Khata 103, Thana No. 140 ,Plot 485	7.13



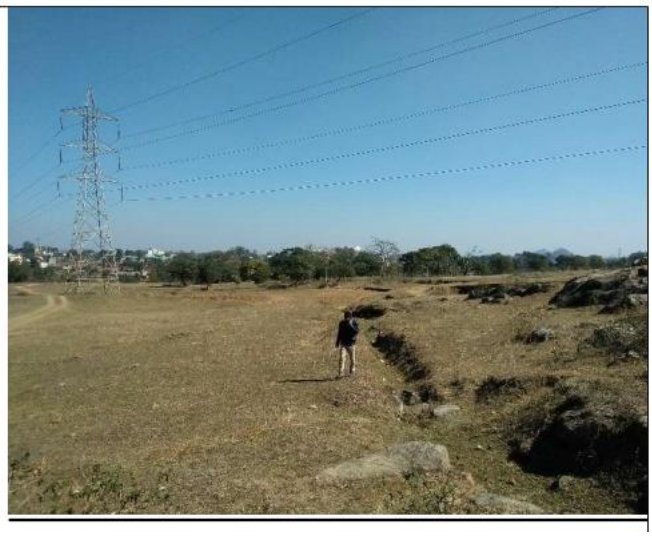
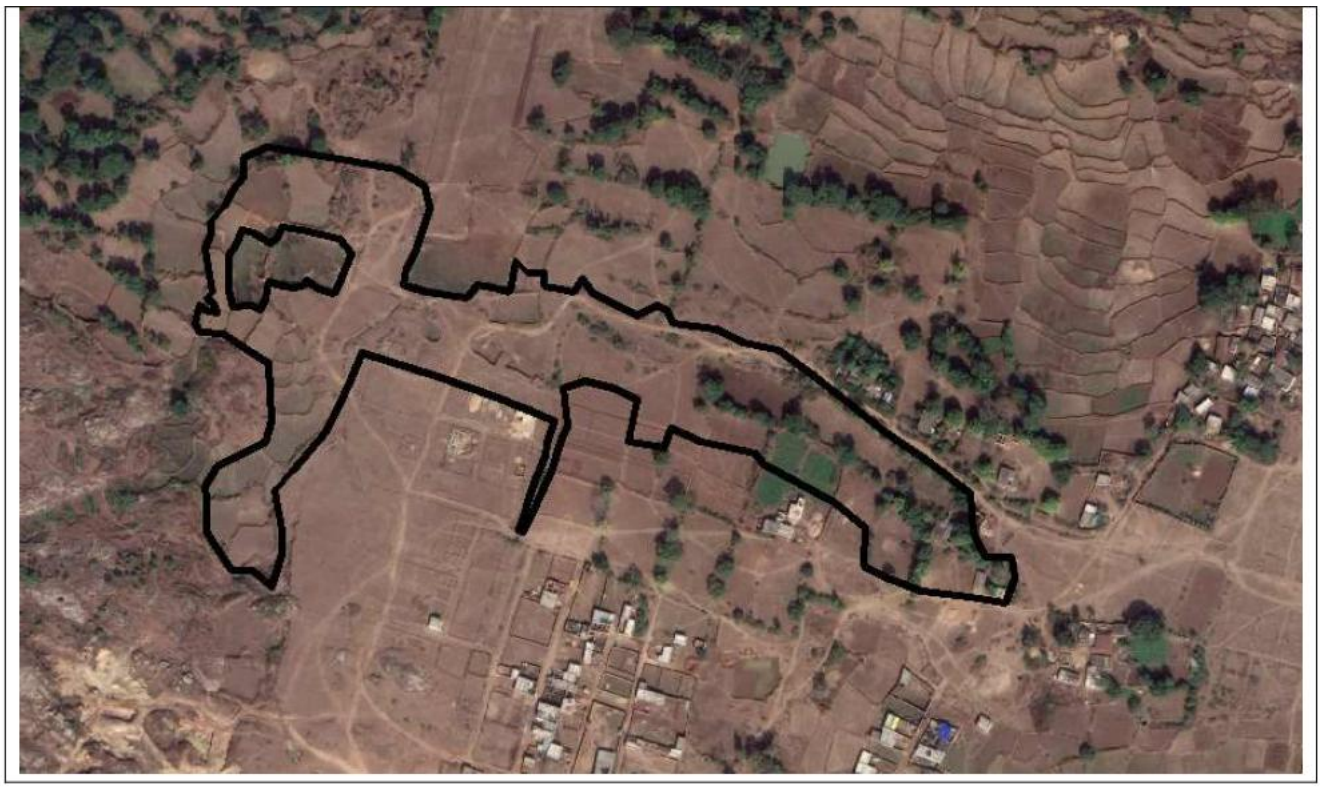
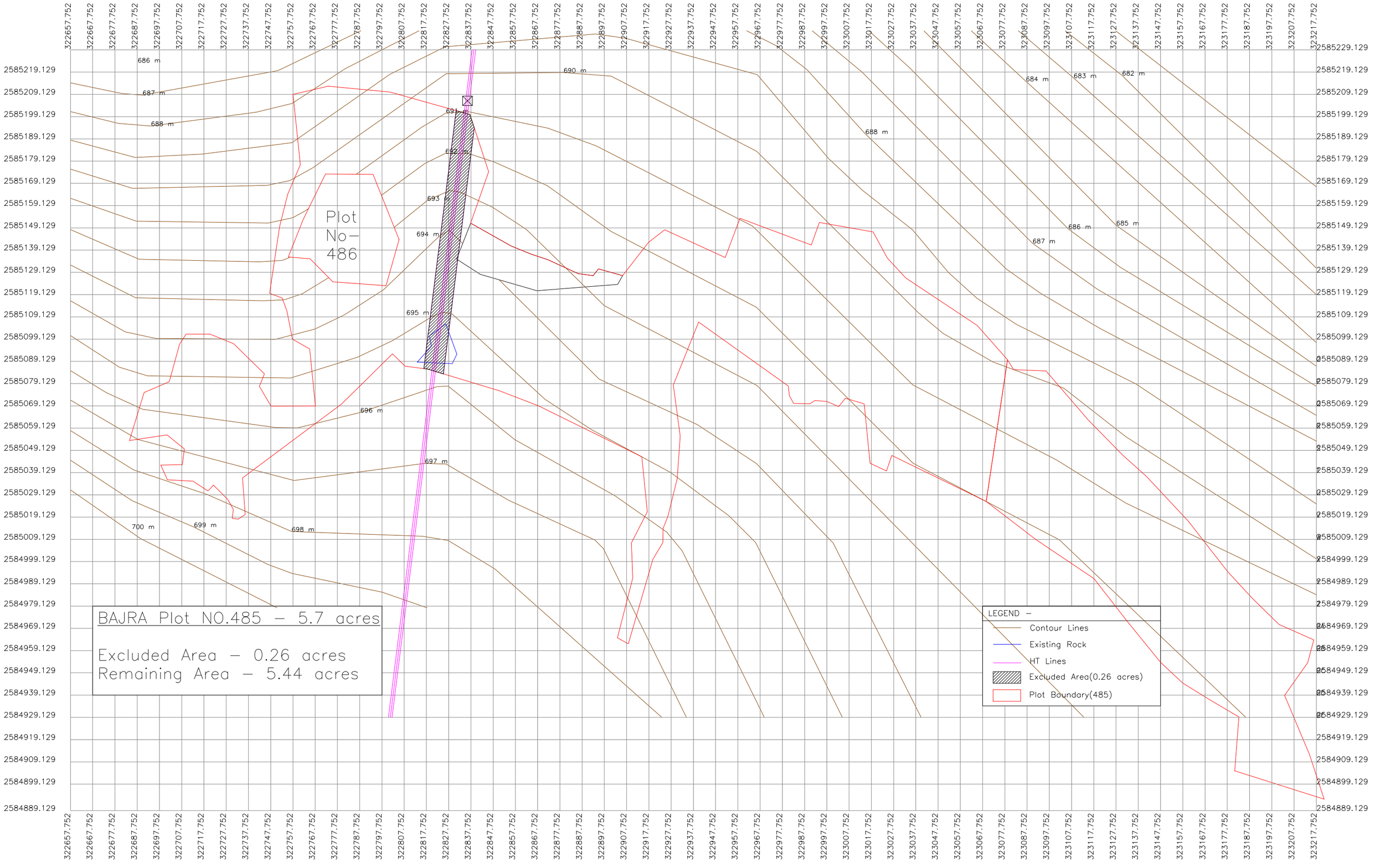


Figure 17: Google Earth Image of the Site





2.2.2 Total Station Survey Map


Plot
No–
486
BAJRA Plot NO.485 – 5.7 acres
Excluded Area – 0.26 acres
Remaining Area – 5.44 acres
LEGEND –
Contour Lines
Existing Rock
HT Lines
Excluded Area(0.26 acres)
Plot Boundary(485)

2.2.3 Soil Testing Report

A

REPORT ON
GEOTECHNICAL INVESTIGATION
FOR PREPARATION OF DETAILED PROJECT REPORT
AND PROJECT MANAGEMENT CONSULTANCY
UNDER PRADHAN MANTRI AWAS YOJNA
FOR "CLUSTER I" OF JHARKHAND
PROJECT : PLOT 485 BAJRA (RANCHI)

CONSULTANT / TECHNICAL ADVISOR

DARASHAW ENGINEERING COMPANY PVT. LTD.

SUBMITTED TO:

JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT COMPANY LTD. (JUIDCO)

Pragati Sadan (RRDA Building), 3rd Floor,
Kutchery Chowk, Ranchi-834 001, Jharkhand

Executed By:

SPARSH ENGINEERING CO.(P)LTD.

Regd. Office :
Flat No. 504, Midland Apartment (West), Anantpur,
Near Overbridge, Doranda, Ranchi – 834 002

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1. INTRODUCTION :

Soil exploration, investigation and testing of soil and rock samples for the construction of proposed Plot-485 Bajra under Ranchi ULB, was entrusted to SPARSH ENGINEERING CO. (P) LTD. The objective was to ascertain the subsoil characteristics, stratification and other necessary data of underlying subsoil stratum at the site for the construction of proposed building. The sub soil investigation work consisted of the following operations:

(i) Sinking 16 nos. Bore holes varying in depths upto a maximum depth of 4.50m below the existing ground level at various locations including collection of undisturbed / disturbed soil samples and conducting Standard Penetration Tests at specified depths.

(ii) Drilling Sx & Nx size borehole in refusal strata (N > 100) in continuation of, including visual identification, collection and preservation of rock (including boulder) core samples in core boxes and determination of core recovery and RQD.

(iii) Reporting of formation at the site for various layers present at their respective depths along with their thickness including location of ground water table.

(iv) Conducting Laboratory Tests on Soil & Rock Samples collected during Boring/Drilling Operation and recommending type of foundation, depth of foundation, bearing capacity for open foundation and pile capacity for pile foundation.

During sinking of bore holes soil samples in disturbed and undisturbed conditions and rock core samples were collected for laboratory tests. The disturbed samples were subjected to tests to obtain soil index properties. The undisturbed soil samples, however, were used mainly for conducting tests to obtain shear strength parameters as well as consolidation characteristics of the soil representing the strata.

Since the investigation could not cover the regional sub-soil features, due weightage for the variations of sub-surface layers in its horizontal and vertical extent is to be given in selecting design basis. The consultant has prepared this report based on the field work and the samples collected from the site by the site in-charge.

2. FIELD WORK :

Geotechnical Investigation was envisaged in an attempt for optimization in the design of foundation for the proposed structures to be constructed at this site. The entire Investigation programmed had been divided mainly into two parts, (I) Field works & (II) Laboratory Tests.

(i) Field works unfold the sub-surface deposit types and their characteristics

(ii) Laboratory tests part would help determining the relevant physical and geotechnical properties of the sub-surface deposits leading to finalization of foundation depths of the structures and the bearing capacity with particular reference to the sub-surface types and their strength parameters and settlement potentials at the site.

2.1. Boring :

Boring was carried out by auger and rotary method as per IS 1892-1979 to sink nominal 150mm diameter boreholes to desired depths and operated by a team of experienced technicians. Flush jointed seamless casings were used to minimize the boreholes and prevent caving of the soil inside the boreholes. The casing pipes were advanced by turning in order to minimize the disturbance. Undisturbed soil samples were collected at suitable intervals or at change of strata whichever is

met earlier by open drive sampling method since it was intended to ascertain the subsoil characteristics. The standing water table in each borehole was determined at least 24 hours after the termination of boring work.

For the boreholes when rock was encountered rotary core drilling technique was adopted down to the explored depth. Drilling was done with standard gravity operated rotary drilling machine as per IS : 6926-1973. In this method the hole was advanced by rotating a system, consisting of series of hollow drill rods to the bottom of which was attached a double tube core barrel with a diamond coring bit, means of a diesel operated engine. When the rod with the coring bit was rotated, downward pressure was applied to the system to obtain penetration in the rocky strata and water under pressure was introduced into the bottom of the hole through the hollow drill rods. Water comes up through the annular space between the drill rods and the bore hole and was collected in the water sump, from where it was re-circulated. Water serves the dual function of cooling the bit as it enters the hole and carrying the cuttings from the bottom of the bore hole on its return journey to the surface.

Seamless flush jointed steel casing of Sx and Nx sizes were used to prevent any caving and water loss from holes and they were inserted simultaneously with the advancement of boring / drilling operations.

2.2. Sampling :

Nominal 100mm diameter undisturbed samples were recovered. The sampling equipment used consists of a two-tier assembly of sample tubes 400mm in length fitted at its lower end. The sampling assembly was driven by means of a jarring link to its full length or as far down as was found practicable. After withdrawal the ends of the tubes were sealed with wax at both ends and capped before transmission to the laboratory. At close intervals in depth, disturbed samples were collected both from split spoon sampler after the standard penetration test and from cutting edge for identification and logging purpose. These were tagged and packed in polythene packets and transported to the laboratory. The depth wise locations of all the undisturbed and disturbed samples were used in the preparation of borehole log data and for general identification and classification purposes.

2.3. Standard Penetration Test :

Standard Penetration Tests were conducted in the boreholes at suitable intervals as per IS: 2131-1963 using a split spoon sampler. The split spoon sampler used is of a standard design having an outer diameter of 50.8 mm and inner diameter of 35mm, driving with a monkey weighing 63.5 kgs, falling freely from a height of 75 cm. A record of the number of blows required to penetrate every 15 cm to a maximum depth of 45 cm was made. The first 15 cm of drive was considered to be seating drive and was neglected. To total blows required to effect each 15 cm of penetration was recorded. The "N" values were obtained by counting the number of blows required to drive the spoon 15 cm to 45 cm. On completion of a test the split spoon sampler was opened and soil specimens were preserved in polythene bags for logging purpose.

All the boreholes were sunk with winch. However, raising of hammer for SPT was done manually. Hence there will not be any inertia loss and the efficiency of hammer blows should be considered as 100%.

2.4. Measurement of Water Table :

Level of water was noted when struck in. This is termed as observed water level. Standing water level was noted during initial stages of boring, intermediate stage of boring and after 24 hours of removal of casing was also noted and shown in the profile.

2.5. Measurement of % Core Recovery and RQD :

The total length of all the cores obtained from the barrel was measured and % core recovery was computed at site, while for measuring RQD, core length of size less than 100 mm in length was not taken into account, as per IS: 11315 (Part-11)-1987 .

The Bore logs has been enclosed as Annexure-A .

3. LABORATORY TESTING :

For proper identification and classification of the sub-soil deposits and for deriving adequate information regarding its relevant physical and geotechnical properties at the site under investigation, the soil samples from the sampling tubes were extracted in the laboratory by pushing out the core by using the extractor frame. The core was jacked out in a direction that corresponded with the soil movement within the tube during sampling. In general, the following laboratory tests were conducted on the soil samples collected from the exploratory bore holes and sampling points :

In general following tests were carried out in soil Samples :

(i) Visual Engineering Classification

(ii) Grain size analysis (Sieve as well as Hydrometer)

(iii) Consistency Limits

(iv) Determination of Natural Moisture Content (Water content)

(v) Determination of Specific Gravity

(vi) Determination of Bulk & Dry Unit Weight

(vii) Determination of Shear Parameters such as c & ϕ value

The following tests were carried out in Rock Samples:

(i) Dry density and Bulk Density.

(ii) Water content

(iii) Porosity

(iv) Specific Gravity

(v) unconfined Compressive Strength

(vi) coefficient of softening

(vii) Point load strength index test

4. CRITERIA FOR CLASSIFICATION OF ROCK.

A.Rock Classification on the basis of Unconfined compressive strength as per Table.2(IRC-78-2014)

Rock Type	Description	Unconfined compressive Strength (Mpa)
Extremely Strong	Can not be scratched with knife or sharp pick. Breaking of specimen could be done by sledge hammer only.	>200
Very Strong	Can not be scratched with knife or sharp pick. Breaking of specimen required several hard blows of geologist's pick.	100 to 200
Strong	Can be scratched with knife or sharp pick with difficult. Hard blow of hammer required to detach hand specimen.	50 to 100
Moderately Strong	Can be scratched with knife or pick 6mm deep gouges or grooves can be made by hand blow of geologist 's pick. Hand specimen can be detached by moderate blow.	12.5 to 50
Moderately Weak	Can be grooved or gouged 1.5 mm deep by firm pressure of knife or pick point. Can be broken into pieces or chips of about 2.5mm max. size by hard blows of the points of geologist's pick.	5 to 12.5
Weak	Can be grooved or gouged easily with point of pick point. Can be break down in chips to pieces several cm's in size by moderate blows of pick point. Small thin pieces can be broken by finger pressure.	1.25 to 5
Very Weak	Can be carved with knife. Can be broken easily with point of pick. Pieces 25mm or more in thickness can be broken by finger pressure. Can be scratched easily by finger nail.	<1.25

B. **Physically** rock can be classified on following basis:

a) Based on color on examination of rock sample.

b) Based on grain of sample

i, Course Grained, ii. Medium grained, iii. Fine Grained

c) Based upon joint/fracture spacing .

i. Very widely, ii. Widely, iii. Medium, iv. Closely

d) Based upon the condition of weathering .

i. Fresh, ii. Slightly weathered, iii. Moderately weathered, iv. Highly weathered, V. Completely weathered, VI. Residual soil.

C. Based on **RQD** of Rock sample.

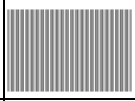
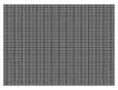
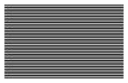
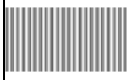
90-100	75-90	50-75	25-50
Excellent	Good	Fair	Very Poor

5. CRITERIA FOR CLASSIFICATION OF SOIL.

Classification and Identification of soil for general engineering Purpose as per IS 1498-1970.

Soil classification including field identification and description.

Division	Sub-Division		Group Letter Symbol	Hatching	Typical Name
COARSE-GRAINED SOIL **More than half material is larger than 75 micron IS sieve Size The smallest partical visiable to the naked eyed.**	**Gravels More than half of coarse fraction is larger than 4.75 mm IS sieve size**	Clean Gravells (Little or no fines)	GW		Well graded gravels, gravels – sand mixture. Little or no fines.
			GP		Poorely graded gravels, gravels –sand mixture. Little or no fines.
		Gravells with fines (Apprectable amount of fines fines)	GM		Silty gravels, poorely graded gravels -sand silt mixture
			GC		Clayey gravels, poorely graded gravels -sand clay mixture
	Sands More than half of coarse fraction is smaller than 4.75 mm IS sieve size	Clean Sands (Little or no fines)	SW		Well graded (sand-gravel and), little or no fines.
			SP		Poorely graded sand-gravely sand, little or no fines.
		Sands with fines (Appreciable amount of fines fines)	SM		Silty sands, poorely graded sand silt mixture
			SC		Clayey sands, poorely graded sand silt mixture

Division	Sub-Division	Group Letter Symbol	Hatching	Typical Name
FINE-GRAINED SOIL More than half material is smaller than 75 micron IS sieve Size The smallest particle visible to the naked eyed.	Silts and clays with low compressibility and liquid limit less than 35.	ML		Inorganic silts and very fined sands, rock flour, silts or clayey fine sands or clayey silt none to low plasticity.
		CL		Inorganic clays ,gravely clays, sandy clays, silty clays, lean clays of low plasticity.
		OL		Organic silt and organics silty clays of low plasticity.
	Silts and clays with medium compressibility and liquid limit greater than 35 & less than 50.	MI		Inorganic silts, silty or clayey fine sands or clayey silt of medium plasticity.
		CI		Inorganic clays, gravely clays, sandy clays, silty clays, lean clays of medium plasticity.
		OI		Organic silt and organics silty clays of medium plasticity.
	Silts and clays with high compressibility and liquid limit greater than 50.	MH		Inorganic silt of high compessibility, micaceous or diatomicaceous fine sandy or silty soil, plastic silt.
		CH		Inorganics clays with high plasticity, clays.
		OH		Organics clays with of medium to high plasticity .
Highly Organic soil		Pt		Peat and other highly organic soil with very high compressibility.

Classification of Coarse-Grained soil based **on laboratory Testing** of soil sample.

Group Symbol	Laboratory Classification Criteria		
GW	Cu greater than 4. Cc Between 1 and 3.	Uniformity Coefficient (Cu)	$Cu=D_{60}/D_{10}$
GP	Not meeting all gradation requirement for GW.	Coefficient of Curvature (Cc)	$(D_{30})^2$
GM	Plastic Index(Ip) less than 4.		$D_{60}XD_{10}$
GC	Plastic Index(Ip) greater than7.	60% finer than size	D_{60}
SW	Cu greater than 6. Cc Between 1 and 3.	30% finer than size	D_{30}
SP	Not meeting all gradation requirement for SW.	10% finer than size	D_{10}
SM	Plastic Index(Ip) less than 4.	plastic Index	Ip
SC	Plastic Index(Ip) greater than7.		

6. COMPUTATION OF BEARING CAPACITY:

6.1.Computation of Bearing Capacity for Rocky Strata

A. Based upon the Clause 6.2 of IS:12070-1987

The computation of bearing capacity has been done as per the provision of clause 6.2 of IS:12070-1987.

The safe bearing pressure should be estimated from the equation:

qs = qc.Nf;

Where,

qs = safe bearing pressure
qc = average uniaxial compressive strength of rock cores,
Nf = empirical coefficient depending on the spacing of discontinuities or as per below table .

= (3+S/Bt)/(10√(1+300§/s)

Where,

§ = Thickness of discontinuities in cm.
S = Spacing of discontinuities in cm.
Bt = Footing width in cm.

Here, the equation included a factor of safety of 3.

The relation given is valid for a rock mass with a spacing of discontinuities greater than 0.3m, aperture (opening) of discontinuities less than 10mm (15mm if filled with soil or rock debris) and foundation width of greater than 0.3m.

Spacing or Discontinuities (cm)	Empirical coefficient (Nf)
300	0 .4
100-300	0.25
30-100	0.1

B. Based upon Clause no. 5.2 of IS:12070-1987

Net safe bearing capacity depending upon the Classification of rock mass is given in clause no.5.2 of IS:12070-1987 is as given below:

NET SAFE BEARING PRESSURE (qns) BASED ON CLASSIFICATION

MATERIAL	**qns(t/sq.m)**
Massive crystalline bedrock including granite, diorite, gneiss, trap rock	1000
Foliated rocks such as schist or slate in sound condition.	400
Bedded limestone in sound condition	400
Sedimentary rock, including hard shales and sandstones	250
Soft or broken bed rock(excluding shale),and soft limestone	100
Soft shale	40

C. Based upon Rock Mass Rating(RMR):

As per provision, clause 5.3 of IS:12070-1987,RMR may also be used to give net allowable pressure as per table given below .This will ensure settlement of raft foundation up to 6m thickness to be less than 12mm.

NET SAFE BEARING PRESSURE BASED ON RMR

Classification No.	I	II	III	IV	V
Description of Rock	Very good	good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qns(t/sq.m)	600-448	440-288	280-151	145-90-58	55-45-40

The RMR of Rock mass can be determined as defined by Bieniawski & modified by Wickham, which is as given below:

	A.CLASSIFICATIO PARAMETERS AND THEIR RATINGS								
	Parameter		Range of Values						
1	Strength of intact rock material	Point-load strength index	>10Mpa	4-10Mpa	2-4Mpa	1-2Mpa	For this low range-uniaxial compressive test is preferred.		
		Uniaxial comp. strength	>250 Mpa	100-250 Mpa	50-100 Mpa	25-50 Mpa	5-25 Mpa	1-5 Mpa	<1 Mpa
	Rating		15	12	7	4	2	1	0
2	Drill core Quality RQD		90% -100%	75% -90%	50% -75%	25% -50%	<25%		
	Rating		20	17	13	8	3		
3	Spacing of discontinuities		>2m	0.6-2.0m	200-600mm	60-200mm	<60mm		
	Rating		20	15	10	8	5		
4	Condition of discontinuities (see-E)		Very rough surfaces Not continuous	Slightly rough surfaces Separation<1mm	Slightly rough surfaces Separation<1mm	Slickenside surfaces or Gouge <5mm	Soft gouge >5mm thick or Separation >5mm		

			No separation Untethered wall rock	Slightly weathered walls	Highly weathered walls	thick or Separation 1-5mm continuous	continuous
	Rating		30	25	20	10	0
5		Inflow per10m tunnel length(l/m)	None	<10	10 to 25	25-125	>125
	Ground Water	(Joint water press)/ (Major principal σ)	0	<0.1	0.1-0.2	0.2-0.5	>0.5
		General conditions	Completely dry	Damp	wet	Dripping	Flowing
	Rating		15	10	7	4	0
B.	RATING ADJUSTMENT FOR DISCONTINUITY ORIENTATIONS(See F)						
Strike and dip orientations			Very favorable	Favorable	Fair	Unfavorable	Very Unfavorable
Rating		Tunnels & mines	0	-2	-5	-10	-12
		Foundations	0	-2	-7	-15	-25
		Slopes	0	-5	-25	-50	
C.	ROCK MASS CLASSES DETERMINED FROM TOTAL RATING						
Rating			100 -81	80-61	60-41	40-21	<21
Class number			I	II	III	IV	V
Description			Very good rock	Good rock	Fair rock	Poor Rock	Very Poor Rock
D.	MEANING OF ROCK CLASSES						
Class number			I	II	III	IV	V
Average stand-up time			20 yrs for 15m span	1 yrs for 10m span	1 week for 5m span	10hrs for 2.5m span	30min for 1m span
Cohesion of rock mass(kpa)			>400	300-400	200-300	100-200	<100
Frictional angle of rock mass(deg)			>45	35-45	25-35	15-25	<15
E.	Guidelines for classification of Discontinuity condition						
Discontinuity length(persistence) Rating			<1m 6	1-3m 4	3-10m 2	10-20m 1	>20m 0
Separation (aperture) Rating			None 6	<0.1mm 5	0.1-1.0mm 4	1-5mm 1	>5mm 0
Roughness Rating			Very rough 6	Rough 5	Slightly rough 3	Smooth 1	Slicken sided 0
Infilling(gouge) Rating			None 6	Hard filling<5mm 4	Hard filling>5mm 2	Soft filling<5mm 2	Soft filling>5mm 0
Weathering Ratings			Unweathered 6	Slightly weathered 5	Moderately weathered 3	Highly weathered 1	Decomposed 0

Correction for submergence, cavities etc.

As per provision clause no.9.1 of IS:12070-1987;

For getting the allowable bearing pressure the safe bearing pressure should be multiplied with the correction factor, given below according to the geological condition .These correction are not applicable for the classification of RMR method.

Allowance should be made for submerged conditions, cavities and slope given below.

(i)	Submerged condition Under water table.	
	a) Rock with discontinuous joints with opening less than 1mm wide;	3/4
	b) Rock with continuous joints with opening 1 to 5 mm wide and filled with clay; and	3/4 to 1/2
	c) Limestone/Dolomite deposit with major cavities filled soil	2/3 to 1/2
(ii)	Cavities	
	Major cavities inside limestone (Core recovery less than 70%)	1/2
(iii)	Slope	
	a) Fair orientation of continuous joints in the slope	1 to 1/2
	b) Unfavorable orientation of continuous joints in slope	1/2 to 1/3

6.2. Computation of Bearing Capacity for Sandy & Clayey Strata

The ultimate net bearing capacity is obtained as per clause 5.1.1 of IS:6403-1981.

a) In case of general shear failure (qd)= C.Nc.Sc.Dcic + q(Nq-1)Sq.dq.iq+ 0.5γ.B.Nγ.Sγ.Dγ.iγ.w'.

b) In case of local shear failure (q'd)=2/3 C.N'c.Sc.Dcic+ q(N'q-1)Sq.dq.iq+0.5γ.B.N'γ.Sγ.Dγ.iγ.w'.

Criteria for analysis as per clause 5,2,1.1 of IS:6403-1981 is given below.

Method of analysis base on relative density			
Relative Density	Void Ratio	Condition	Method of Analysis
Greater than 70%	less than 0.55	Dense	General Shear
Less than 20%	Greater than 0.75	Loose	Local Shear(as well as punching shear)
20% to 70%	0.55 to 0.75	Medium	interpolate between (i & ii)

Where;

C=cohesion in kg/sq.cm

Nc, N'c Nq N'q and Nγ N'γ =Bearing capacity factor

Sc, Sq and Sγ =Shape factor

Dc, Dq and Dγ =Depth factor

ic,iγ,&iγ =inclination Factor

γ =bulk unit weight of foundation soil.

q =effective surcharge at the base level of foundation in (kg/sq.cm)

B =Width of footing(cm)

W' =Correction factor for location of water table.

As per clause no. 5.2.2.1 the ultimate net bearing capacity shall be calculated from the following formula.(Based on SPT Value)

(qd)=q(Nq-1)Sq.dq.iq+ 0.5γ.B.Nγ.Sγ.Dγ.iγ.w'

All parameters are same as above, only Φ is read from fig.1 of IS:6403-1981.

The bearing capacity factor ,Depth factor, Shape Factor, inclination factor & effect of water table given below.

Bearing Capacity Factor(IS:6403-1981)			
Φ (deg)	Nc	Nq	Nγ
0	5.14	1	0
5	6.14	1.57	0.45
10	8.35	2.47	1.22
15	10.98	3.94	2.65
20	14.83	6.4	5.39
25	20.72	10.66	10.88
30	30.14	18.4	22.4
35	46.12	33.3	48.03
40	75.31	64.2	109.41
45	138.88	134.88	271.76
50	266.89	319.07	762.89

For obtaining N'c, N'q& N'γ, Φ'=tan-1(0.67tan Φ) and the values are respectively.

Shape Factor(IS:6403-1981)			
Sl.no shape of base	Sc	Sq	Sγ
Continious strip	1	1	1
Rectangle	1+0.2B/L	1+0.2B/L	1-0.4B/L
Square	1.3	1.2	0.8
Circle	1.3	1.2	0.6
where,B the diameter in the bearing capacity formula			

The depth factor shall be as under:

dc=1+ 0.2Dt/B√NΦ

dq=dy=1 for Φ<10deg.

dq=dy=1+0.1Dt/B√NΦ for Φ>10deg.

Here, the correction is to be applied only when back filling is done with proper compaction.
The Inclination Factor shall be under:

ic =iq=(1-a/90)^2

iy =(1-a/ Φ)^2

Where,

a =Inclination of the load to the vertical in deg.

Φ = Angle of shearing resistance of soil in deg.

Effect of Water table :

a) If the water table is likely to permanently remain at or below a depth of (Dt+B) beneath the ground level surrounding the footing then W'=1.
b) If the water table is located at a depth Dt or likely to rise to the base of footing or above the value of W' shall be taken as 0.5
c) If the water table is likely to permanently got located at a depth Dt<Dw<(Dt+B),then the value of W' be obtained by linear interpolation.

In the present case, the foundation has been provided at rocky strata, hence the bearing capacity has been computed for rocky strata and the same has been enclosed.

7. RECOMMENDATION.

7.1.Recommended Net Safe Bearing Capacity for open foundation.

Based upon the parameter, sub-soil profile, the lab test result and calculation of net Safe Bearing capacity for open type of foundation at the founding level is recommended and tabulated below.

Determmination Ultimate Net Bearing capacity in soil based upon c-Φ value

The Net Ultimate Bearing Capacity is given q_u= C.Nc.Sc.Dc+q.Nq.Sq.Dq+0.5γ.Nγ.Sγ.Dγ-q

CHOICE OF FOUNDATION & FOUNDING LEVEL

Bore Hole No.	Depth (Df)	Width (B)	Length (L)	Cohesion (C = t/sqm)	Overburden Pressure (q = t/sqm)	Bulk Density below Foundation (γ)	Submerge Density	ϕ/	Net Ultimate B.C. in t/sqm	Net Safe B.C. in t/sqm
BH-1	1.00	2.00	1.50	0.91	1.278	2.28	1.278	18	28	11
	3.00	3.00	2.00	2.27	3.825	2.28	1.275	16	59	24
BH-2	1.50	2.00	2.00	1.44	1.914	2.28	1.276	17	36	14
	3.50	3.50	3.50	2.29	4.452	2.27	1.272	16	65	26
BH-3	1.00	2.00	1.50	1.37	1.269	2.27	1.269	18	34	14
	3.00	3.00	2.00	2.10	3.795	2.27	1.265	16	61	24
BH-4	1.00	2.00	1.50	0.80	1.276	2.28	1.276	18	26	11
	3.00	3.00	2.00	2.10	3.816	2.27	1.272	16	61	24
BH-5	1.00	2.00	2.00	1.08	1.31	2.31	1.310	18	29	12
	3.00	3.50	3.50	0.99	3.885	2.30	1.295	18	46	18
BH-6	1.00	2.00	1.50	0.91	1.274	2.27	1.274	18	28	11
	3.00	3.00	2.00	0.82	3.3	2.10	1.1	18	43	17
BH-7	1.00	2.00	1.50	0.94	1.451	2.45	1.451	18	30	12
	3.00	3.00	2.00	0.96	3.828	2.28	1.276	18	49	20
BH-8	1.00	2.00	2.00	0.91	1.272	2.27	1.272	18	26	10
	3.00	3.50	3.50	0.94	4.35	2.45	1.450	18	53	21
BH-9	1.00	2.00	1.50	0.71	1.395	2.40	1.395	19	28	11
	3.00	3.00	2.00	1.05	4.23	2.41	1.41	18	49	20
BH-10	1.00	2.00	1.50	0.94	1.451	2.45	1.451	18	30	12
	3.00	3.00	2.00	0.94	4.176	2.39	1.392	18	51	21
BH-11	1.00	2.00	2.00	0.76	1.276	2.28	1.276	19	26	10
	3.00	3.50	3.50	0.94	3.816	2.27	1.272	18	49	20
BH-12	1.00	2.00	1.50	0.98	1.395	2.40	1.395	18	31	12
	3.00	3.00	2.00	0.93	4.38	2.46	1.46	19	53	21
BH-13	1.00	2.00	1.50	1.10	1.421	2.42	1.421	17	30	12
	3.00	3.00	2.00	0.52	4.23	2.41	1.41	19	44	17
BH-14	1.00	2.00	1.50	0.94	1.451	2.45	1.451	18	30	12
	3.00	3.00	2.00	0.76	4.176	2.39	1.392	19	53	21
BH-15	1.00	2.00	2.00	0.82	1.276	2.28	1.276	18	27	11
	3.00	3.50	3.50	0.60	3.816	2.27	1.272	18	39	15
BH-16	1.00	2.00	1.50	0.95	1.27	2.27	1.27	19	29	12
	3.00	3.00	2.00	0.97	3.795	2.27	1.265	18	45	18

8. BORELOG :

Bore Log Data Sheet									BH. No.- 01		
Site	PLOT 485, BAJRA			Client:	Jharkhand Urban Infrastructure Development Corporation						
Type of Boring		Auger & Rotary		Job No. :							
Dia of Hole (mm):		150		Bore Hole No. :			BH. No.- 01				
Depth (M):		4.00									
Water Struc:		Ground Water:	N/A	Location of Bore Hole			Marked-01				
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.	
				0-150	150-300	300-450	N				
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1			
		1.00	2.00	8	9	10	19				
Organic Silt Clay (OL)		2.00	3.00	10	12	14	26				
		3.00	4.00					UDS-2/1			

Bore Log Data Sheet									BH. No.- 02		
Site	PLOT 485, BAJRA			Client:	Jharkhand Urban Infrastructure Development Corporation						
Type of Boring		Auger & Rotary		Job No. :							
Dia of Hole (mm):		150		Bore Hole No. :			BH. No.- 02				
Depth (M):		4.50									
Water Struc:		Ground Water:	N/A	Location of Bore Hole			Marked-02				
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.	
				0-150	150-300	300-450	N				
Organic Clay Soil (OH)		0.00	1.50					UDS-1/1			
		1.50	2.50	8	9	11	20				
Organic Silt Clay (OL)		2.50	3.50	10	12	15	27				
		3.50	4.50					UDS-2/1			

Bore Log Data Sheet										BH. No.- 03
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 03			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-03			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	10	12	22			
Organic Silt Clay (OL)		2.00	3.00	10	13	15	28			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 04
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 04			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-04			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	9	12	21			
Organic Silt Clay (OL)		2.00	3.00	10	13	14	27			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 05
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 05			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-05			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	9	12	21			
Organic Silt Clay (OL)		2.00	3.00	10	13	14	27			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 06
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 06			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-06			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	10	12	22			
Organic Silt Clay (OL)		2.00	3.00	10	13	15	28			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 07
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 07			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-07			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	11	12	23			
Organic Silt Clay (OL)		2.00	3.00	10	13	15	28			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 08
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 08			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-08			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	10	11	21			
Organic Silt Clay (OL)		2.00	3.00	10	12	15	27			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 09
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 09			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-09			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	10	11	21			
Organic Silt Clay (OL)		2.00	3.00	10	12	15	27			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 10
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 10			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-10			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	10	12	22			
Organic Silt Clay (OL)		2.00	3.00	10	13	15	28			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 11
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 11			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-11			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	9	12	21			
Organic Silt Clay (OL)		2.00	3.00	10	13	14	27			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 12
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 12			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-12			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	10	11	21			
Organic Silt Clay (OL)		2.00	3.00	10	13	15	28			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 13
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 13			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-13			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	10	12	22			
Organic Silt Clay (OL)		2.00	3.00	10	13	14	27			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 14
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 14			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-14			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	11	12	23			
Organic Silt Clay (OL)		2.00	3.00	10	13	15	28			
		3.00	4.00					UDS-2/1		

Bore Log Data Sheet										BH. No.- 15
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 15			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-15			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	10	11	21			
Organic Silt Clay (OL)		2.00	3.00	10	12	13	25			
		3.00	4.00					UDS-2/1		

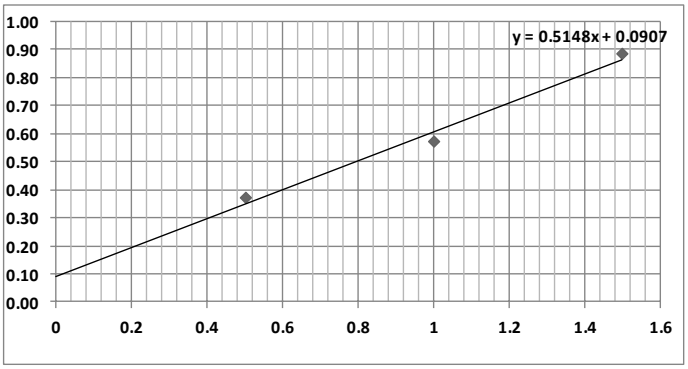
Bore Log Data Sheet										BH. No.- 16
Site	PLOT 485, BAJRA				Client:	Jharkhand Urban Infrastructure Development Corporation				
Type of Boring		Auger & Rotary			Job No. :					
Dia of Hole (mm):		150			Bore Hole No. :		BH. No.- 16			
Depth (M):		4.00								
Water Struc:		Ground Water:	N/A		Location of Bore Hole		Marked-16			
Description of Strata	Symbol	From (M)	To (M)	SPT Record				Sample Ref. No.	Core Revry (%)	R.Q.D.
				0-150	150-300	300-450	N			
Organic Clay Soil (OH)		0.00	1.00					UDS-1/1		
		1.00	2.00	8	10	12	22			
Organic Silt Clay (OL)		2.00	3.00	10	13	14	27			
		3.00	4.00					UDS-2/1		

9. DIRECT SHEAR TEST :

Condition of test:	CQ		Bore hole No.	BH-1
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

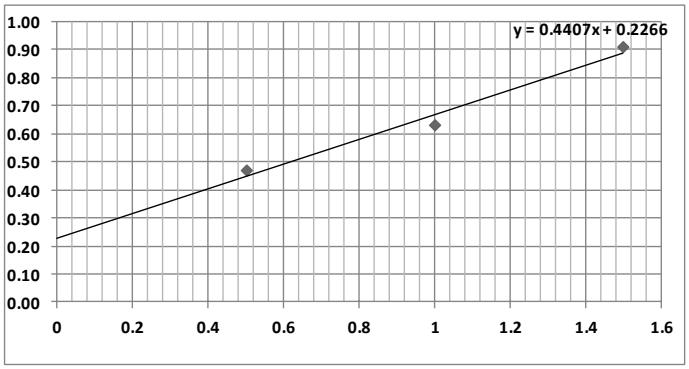
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.091	27.24	2.071	10.00
1	67	18.76	0.57	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-1
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.0M
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

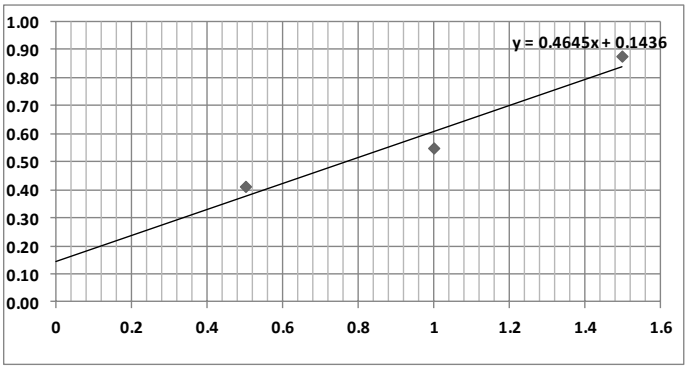
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	56	15.68	0.47	400	33.600	0.227	23.79	2.00	14.00
1	74	20.72	0.63	500	33.000				
1.5	105	29.4	0.91	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-2
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.5M
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 2			Proving ring constant	0.28kg/div.

TEST Results

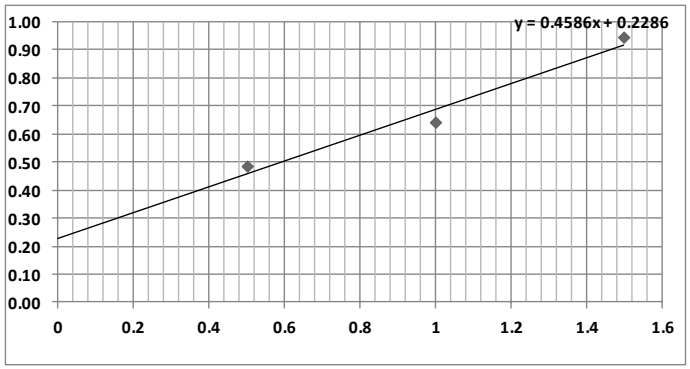
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	49	13.72	0.41	400	33.600	0.144	24.92	2.07	10.00
1	64	17.92	0.54	500	33.000				
1.5	101	28.28	0.87	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-2
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.5M
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 2			Proving ring constant	0.28kg/div.

TEST Results

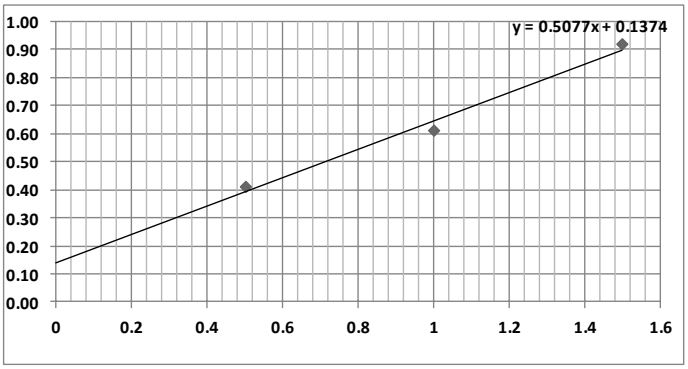
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	58	16.24	0.48	400	33.600	0.229	24.64	1.98	15.00
1	75	21	0.64	500	33.000				
1.5	109	30.52	0.94	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-3
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 3			Proving ring constant	0.28kg/div.

TEST Results

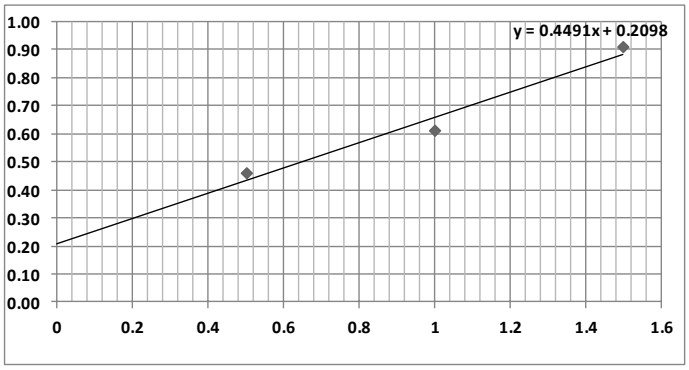
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	49	13.72	0.41	400	33.600	0.137	26.92	2.06	10.00
1	72	20.16	0.61	500	33.000				
1.5	106	29.68	0.92	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-3
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.0M
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 3			Proving ring constant	0.28kg/div.

TEST Results

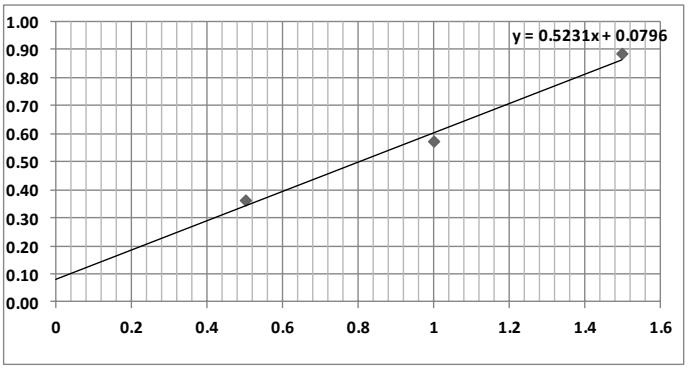
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	55	15.4	0.46	400	33.600	0.210	24.18	1.99	14.00
1	72	20.16	0.61	500	33.000				
1.5	105	29.4	0.91	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-4
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

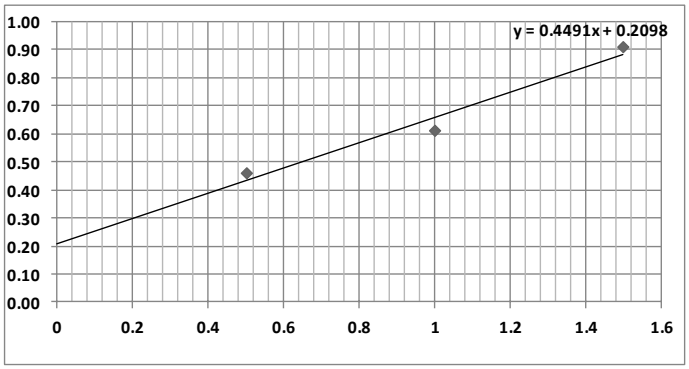
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	43	12.04	0.36	400	33.600	0.080	27.62	2.069	10.00
1	67	18.76	0.57	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-4
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.0M
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

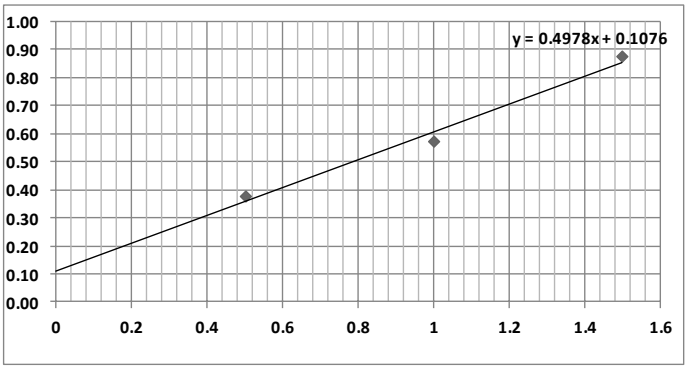
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	55	15.4	0.46	400	33.600	0.210	24.18	1.99	14.00
1	72	20.16	0.61	500	33.000				
1.5	105	29.4	0.91	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-5
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

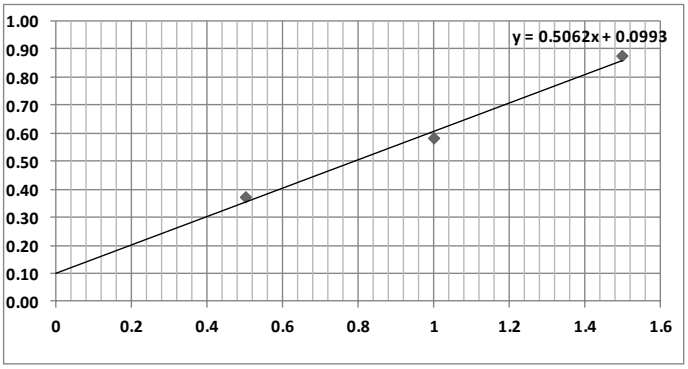
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	45	12.6	0.38	400	33.600	0.108	26.47	2.100	10.00
1	67	18.76	0.57	500	33.000				
1.5	101	28.28	0.87	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-5
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

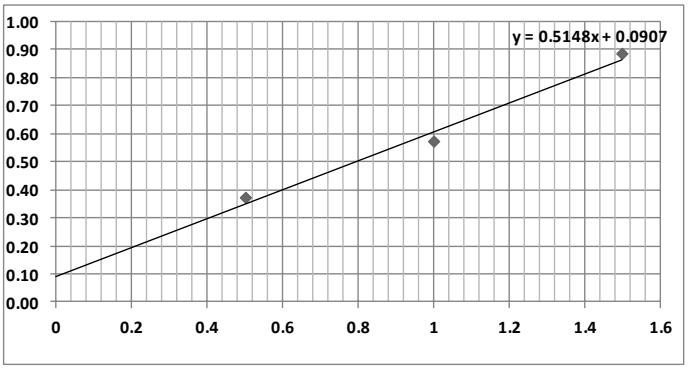
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.099	26.85	2.013	14.00
1	68	19.04	0.58	500	33.000				
1.5	101	28.28	0.87	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-6
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

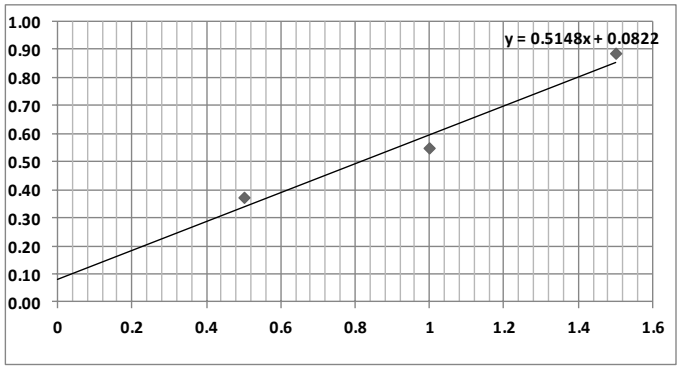
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.091	27.24	2.067	10.00
1	67	18.76	0.57	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-6
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

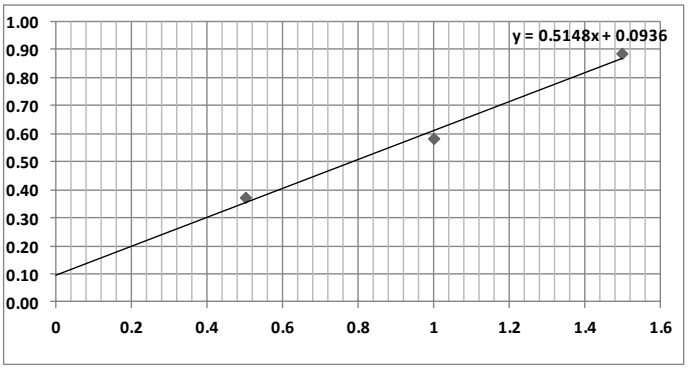
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.082	27.24	1.842	14.00
1	64	17.92	0.54	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-7
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

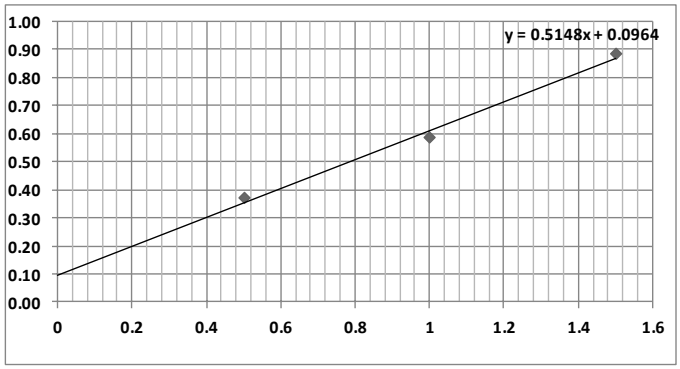
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.094	27.24	2.228	10.00
1	68	19.04	0.58	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-7
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

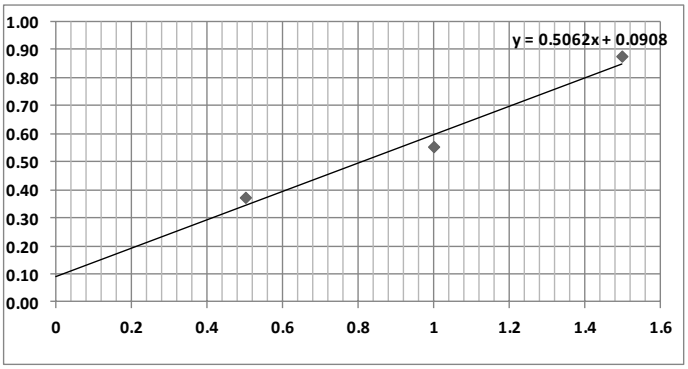
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.096	27.24	1.996	14.00
1	69	19.32	0.59	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-8
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

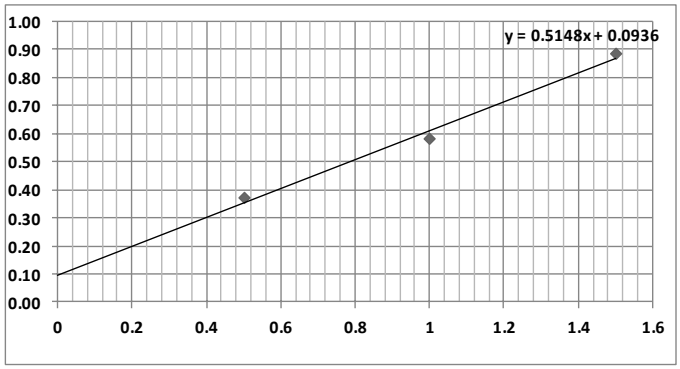
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.091	26.85	2.065	10.00
1	65	18.2	0.55	500	33.000				
1.5	101	28.28	0.87	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-8
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

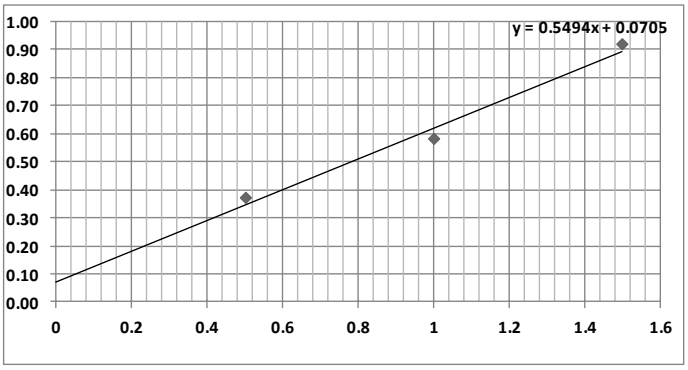
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.094	27.24	2.149	14.00
1	68	19.04	0.58	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-9
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

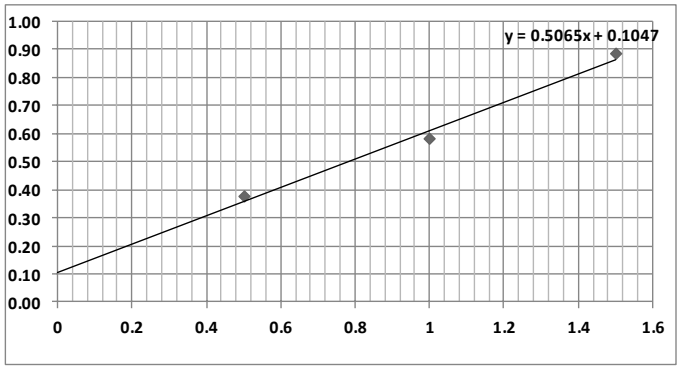
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.071	28.78	2.177	10.00
1	68	19.04	0.58	500	33.000				
1.5	106	29.68	0.92	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-9
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

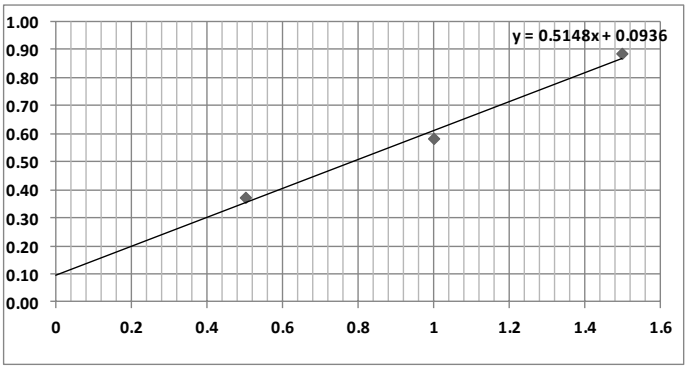
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	45	12.6	0.38	400	33.600	0.105	26.86	2.114	14.00
1	68	19.04	0.58	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-10
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

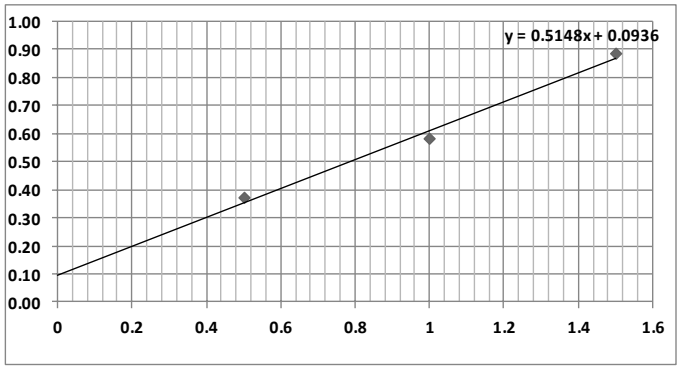
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.094	27.24	2.228	10.00
1	68	19.04	0.58	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-10
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

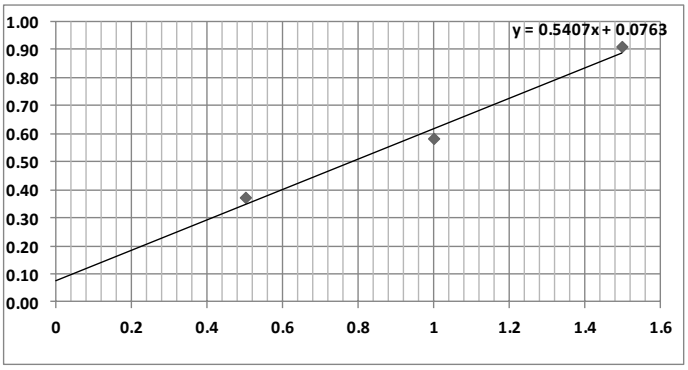
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.094	27.24	2.098	14.00
1	68	19.04	0.58	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-11
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

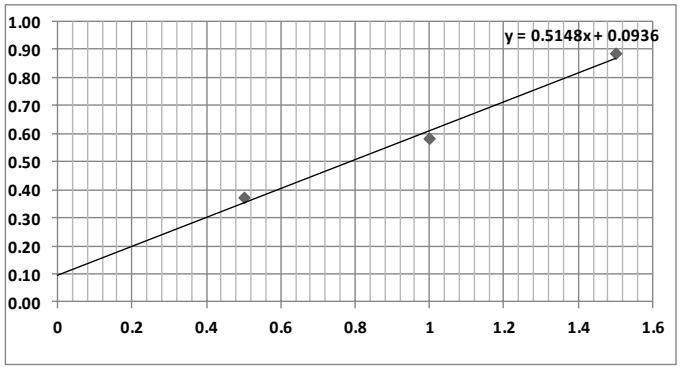
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.076	28.40	2.069	10.00
1	68	19.04	0.58	500	33.000				
1.5	105	29.4	0.91	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-11
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

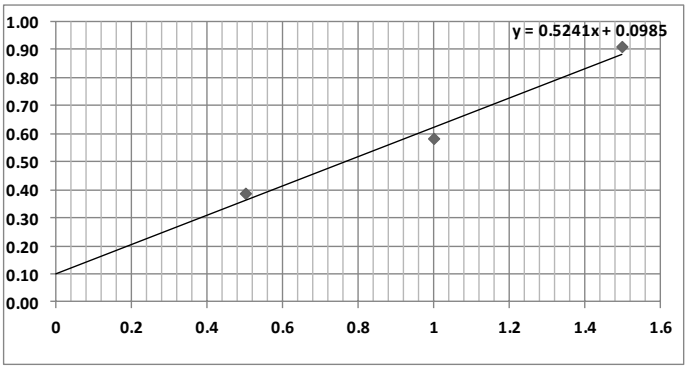
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.094	27.24	1.976	15.00
1	68	19.04	0.58	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-12
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

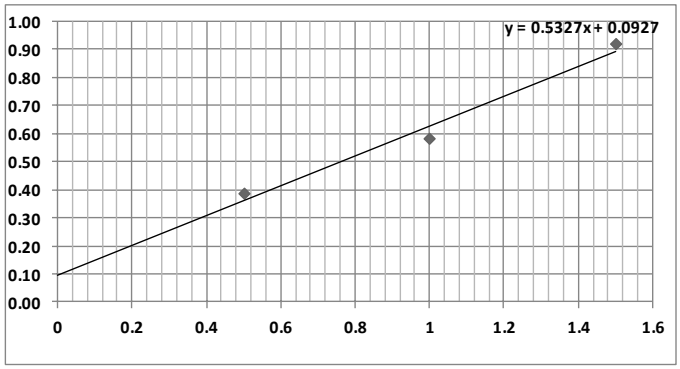
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	46	12.88	0.38	400	33.600	0.098	27.66	2.177	10.00
1	68	19.04	0.58	500	33.000				
1.5	105	29.4	0.91	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-12
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

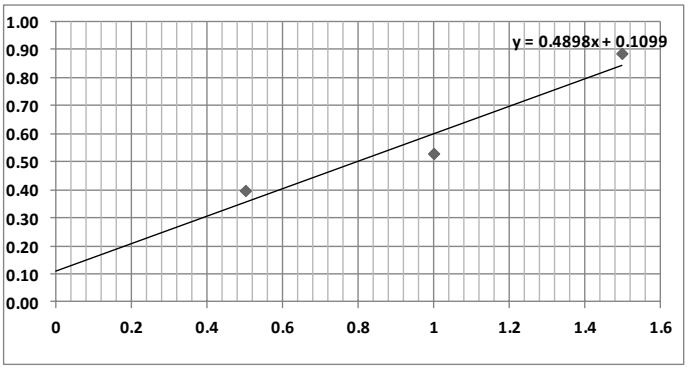
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	46	12.88	0.38	400	33.600	0.093	28.04	2.158	14.00
1	68	19.04	0.58	500	33.000				
1.5	106	29.68	0.92	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-13
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

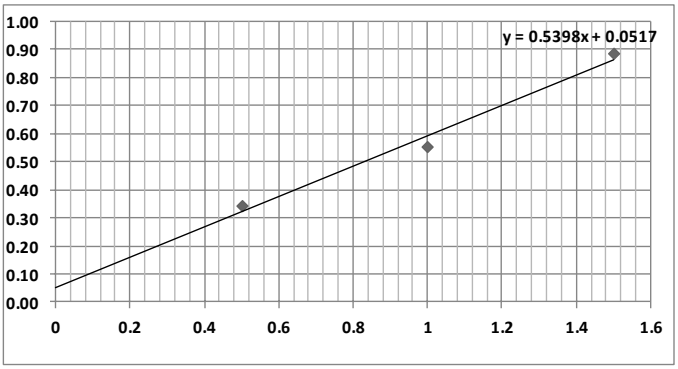
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	47	13.16	0.39	400	33.600	0.110	26.10	2.201	10.00
1	62	17.36	0.53	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-13
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

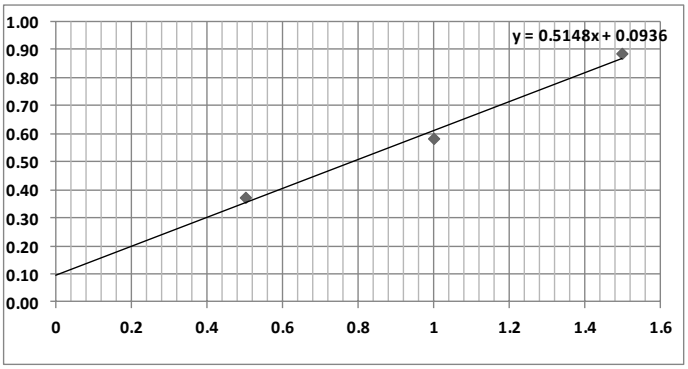
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	41	11.48	0.34	400	33.600	0.052	28.36	2.114	14.00
1	65	18.2	0.55	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-14
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

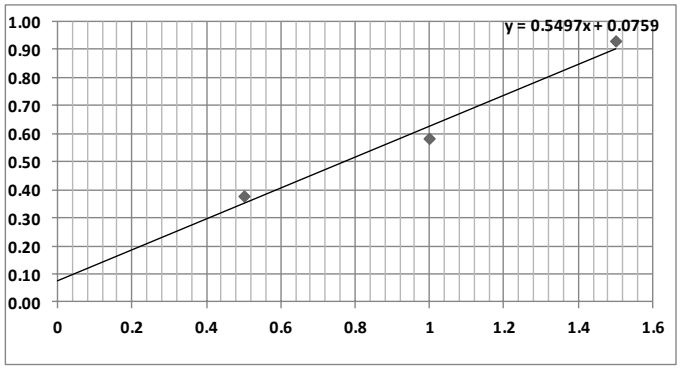
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.094	27.24	2.228	10.00
1	68	19.04	0.58	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-14
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

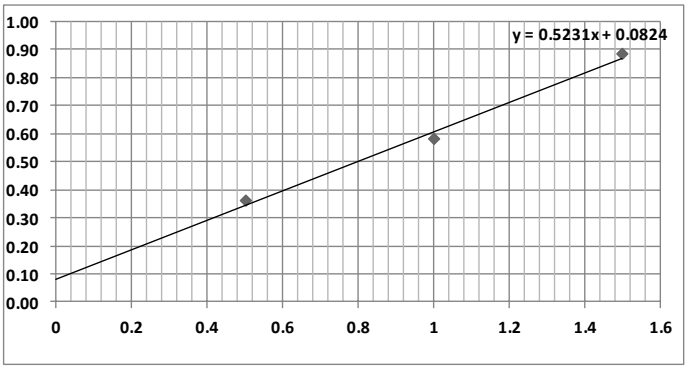
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	45	12.6	0.38	400	33.600	0.076	28.80	2.080	15.00
1	68	19.04	0.58	500	33.000				
1.5	107	29.96	0.92	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-15
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

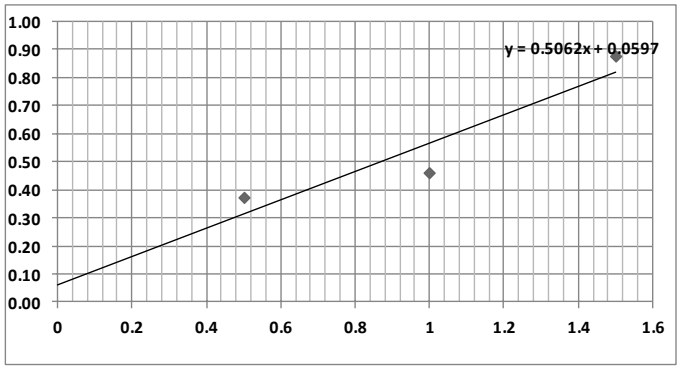
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	43	12.04	0.36	400	33.600	0.082	27.62	2.069	10.00
1	68	19.04	0.58	500	33.000				
1.5	102	28.56	0.88	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-15
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

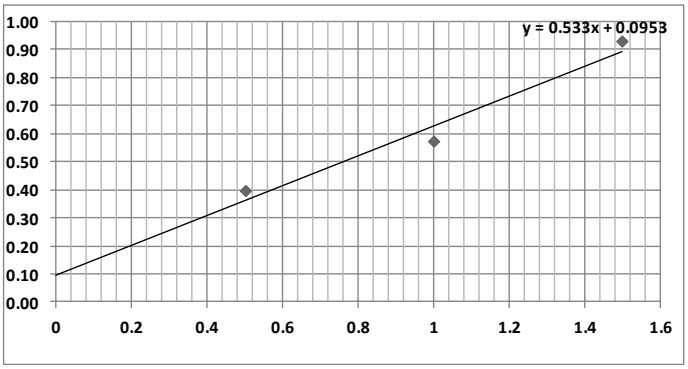
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.060	26.85	1.976	15.00
1	54	15.12	0.46	500	33.000				
1.5	101	28.28	0.87	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-16
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	1.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

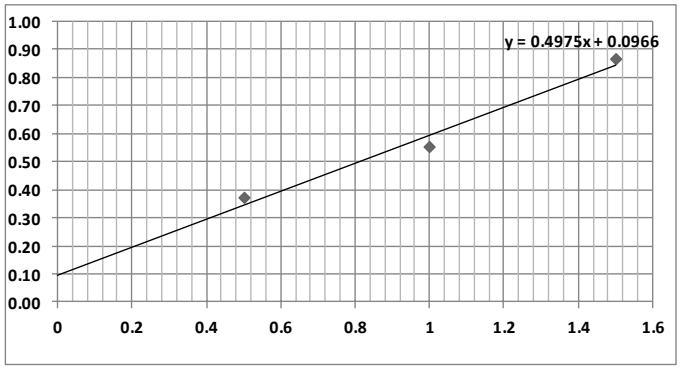
Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	47	13.16	0.39	400	33.600	0.095	28.06	2.064	10.00
1	67	18.76	0.57	500	33.000				
1.5	107	29.96	0.92	600	32.400				



Condition of test:	CQ		Bore hole No.	BH-16
Length of sample:(L)	60mm	DIRECT SHEAR TEST	Depth of sample	3.00
Width of sample:(W)	60mm	IS:2720(Part11)-1993	Least count of gauge	0.01mm/div.
BH 1			Proving ring constant	0.28kg/div.

TEST Results

Normal Stress (kg/sq.cm)	Dial read.	Load gauge Reading (KG)	Shear stress (kg/sq.cm)	Compression Gauge Reading	corrected area	C	φ (Deg)	Dry density (γ_d) gm/cc	Moisture Content(W) %
		at Failure							
Kg/sq.cm		Div.							
0.5	44	12.32	0.37	400	33.600	0.097	26.45	1.987	14.00
1	65	18.2	0.55	500	33.000				
1.5	100	28	0.86	600	32.400				



10. LAB TEST RESULT :

SOIL TEST DATA SHEET

Project Name: Geotechnical investigation report for proposed housing compex at Plot 485-Bajra under Ranchi ULB, Jharkhand.

Client : JUIDCO

Consultant : SPARSH ENGINEERING COMPANY PVT.LTD **Structure-Housing**

SL NO.	Type of Sample	Depth m	DENSITY		NMC %	S_G	Grain Size Analysis				Consistancy Limit			Soil Classification	Shear Parameter			Consolidation	
			g_b gm/cm^3	g_d gm/cm^3			GRAVEL %	SAND %	SILT %	CLAY %	W_L %	W_P %	I_P %		Type of Test	c_u Kg/cm^2	ϕ_u Deg.	e_o	C_c cm2/ kg
BH-1	UDS-1/1	1.00	2.278	2.071	10.00	2.43	10.80	66.40	12.00	10.80	42.00	26.00	16.00	OH	-	0.091	27.240	-	-
	UDS-2/1	3.00	2.275	2.00	14.00	2.39	10.80	65.80	11.90	11.50	46.00	27.00	19.00	OL	-	0.227	23.785	-	-
BH-2	UDS-1/2	1.50	2.276	2.07	10.00	2.46	10.85	66.35	11.80	11.00	46.00	27.00	19.00	OH	-	0.144	24.915	-	-
	UDS-2/2	3.50	2.272	1.98	15.00	2.41	10.10	66.20	11.70	12.00	47.00	27.00	20.00	OL	-	0.229	24.638	-	-
BH-3	UDS-1/1	1.00	2.269	2.063	10.00	2.46	10.40	66.00	11.60	12.00	44.00	26.00	18.00	OH	-	0.137	26.918	-	-
	UDS-2/1	3.00	2.265	1.99	14.00	2.48	11.90	65.80	11.50	10.80	47.00	27.00	20.00	OL	-	0.210	24.184	-	-
BH-4	UDS-1/1	1.00	2.276	2.069	10.00	2.43	9.40	67.20	12.00	11.40	42.00	26.00	16.00	OH	-	0.080	27.616	-	-
	UDS-2/1	3.00	2.272	1.99	14.00	2.39	10.10	66.50	11.90	11.50	46.00	27.00	19.00	OL	-	0.210	24.184	-	-
BH-5	UDS-1/2	1.00	2.310	2.10	10.00	2.46	7.70	69.50	11.80	11.00	46.00	27.00	19.00	OH	-	0.108	26.466	-	-
	UDS-2/2	3.00	2.295	2.01	14.00	2.41	6.30	70.00	11.70	12.00	47.00	27.00	20.00	OL	-	0.099	26.847	-	-
BH-6	UDS-1/1	1.00	2.274	2.067	10.00	2.46	5.10	71.10	11.80	12.00	44.00	26.00	18.00	OH	-	0.091	27.240	-	-
	UDS-2/1	3.00	2.100	1.84	14.00	2.48	5.30	72.20	11.70	10.80	48.00	28.00	20.00	OL	-	0.082	27.240	-	-
BH-7	UDS-1/1	1.00	2.451	2.228	10.00	2.43	6.00	71.00	11.60	11.40	42.00	26.00	16.00	OH	-	0.094	27.240	-	-
	UDS-2/1	3.00	2.276	2.00	14.00	2.39	7.00	70.00	11.50	11.50	46.00	27.00	19.00	OL	-	0.096	27.240	-	-
BH-8	UDS-1/2	1.00	2.272	2.07	10.00	2.46	8.60	69.50	10.90	11.00	42.00	26.00	16.00	OH	-	0.091	26.847	-	-
	UDS-2/2	3.00	2.450	2.15	14.00	2.41	11.00	66.00	11.00	12.00	47.00	27.00	20.00	OL	-	0.094	27.240	-	-
BH-9	UDS-1/1	1.00	2.395	2.177	10.00	2.46	10.90	65.90	11.20	12.00	44.00	26.00	18.00	OH	-	0.071	28.784	-	-
	UDS-2/1	3.00	2.410	2.11	14.00	2.48	12.90	65.00	11.30	10.80	47.00	27.00	20.00	OL	-	0.105	26.861	-	-

L/S : Left Side — R/S : Right Side

g_b : Bulk Density — NMC : Natural Moisture Content — W_P : Plastic Limit — S_G : Specific gravity — ϕ_u :Undrained Angle of Friction

g_d : Dry Density — W_L : Liquid Limit — I_P : Plasticity Index — C_u : Undrain Cohesion — C_c :Coefficient of Consolidation

SOIL TEST DATA SHEET

Project Name: Geotechnical investigation report for proposed housing compex at Plot 485-Bajra under Ranchi ULB, Jharkhand.

Client : JUIDCO

Consultant : SPARSH ENGINEERING COMPANY PVT.LTD **Structure-Housing**

SL NO.	Type of Sample	Depth m	DENSITY		NMC %	S_G	Grain Size Analysis				Consistancy Limit			Soil Classification	Shear Parameter			Consolidation	
			g_b gm/cm^3	g_d gm/cm^3			GRAVEL %	SAND %	SILT %	CLAY %	W_L %	W_P %	I_P %		Type of Test	c_u Kg/cm^2	ϕ_u Deg.	e_o	C_c cm2/ kg
BH-10	UDS-1/1	1.00	2.451	2.228	10.00	2.43	11.95	65.90	10.75	11.40	42.00	26.00	16.00	OH	-	0.094	27.240	-	-
	UDS-2/1	3.00	2.392	2.10	14.00	2.39	12.70	64.80	11.00	11.50	49.00	28.00	21.00	OL	-	0.094	27.240	-	-
BH-11	UDS-1/2	1.00	2.276	2.07	10.00	2.46	12.00	65.00	12.00	11.00	48.00	28.00	20.00	OH	-	0.076	28.402	-	-
	UDS-2/2	3.00	2.272	1.98	15.00	2.41	11.00	64.00	13.00	12.00	47.00	27.00	20.00	OL	-	0.094	27.240	-	-
BH-12	UDS-1/1	1.00	2.395	2.177	10.00	2.46	10.00	66.00	12.00	12.00	48.00	28.00	20.00	OH	-	0.098	27.658	-	-
	UDS-2/1	3.00	2.460	2.16	14.00	2.48	14.20	64.00	11.00	10.80	47.00	27.00	20.00	OL	-	0.093	28.045	-	-
BH-13	UDS-1/1	1.00	2.421	2.201	10.00	2.46	10.10	67.00	10.90	12.00	46.00	27.00	19.00	OH	-	0.110	26.096	-	-
	UDS-2/1	3.00	2.410	2.11	14.00	2.48	13.20	65.00	11.00	10.80	47.00	27.00	20.00	OL	-	0.052	28.361	-	-
BH-14	UDS-1/1	1.00	2.451	2.228	10.00	2.43	8.60	68.00	12.00	11.40	42.00	26.00	16.00	OH	-	0.094	27.240	-	-
	UDS-2/1	3.00	2.392	2.08	15.00	2.39	10.40	66.00	12.10	11.50	46.00	27.00	19.00	OL	-	0.076	28.797	-	-
BH-15	UDS-1/2	1.00	2.276	2.07	10.00	2.46	11.20	65.90	11.90	11.00	46.00	27.00	19.00	OH	-	0.082	27.616	-	-
	UDS-2/2	3.00	2.272	1.98	15.00	2.41	9.70	66.00	12.30	12.00	49.00	28.00	21.00	OL	-	0.060	26.847	-	-
BH-16	UDS-1/1	1.00	2.270	2.064	10.00	2.46	12.00	65.00	11.00	12.00	44.00	26.00	18.00	OH	-	0.095	28.059	-	-
	UDS-2/1	3.00	2.265	1.99	14.00	2.48	13.20	64.00	12.00	10.80	47.00	27.00	20.00	OL	-	0.097	26.452	-	-

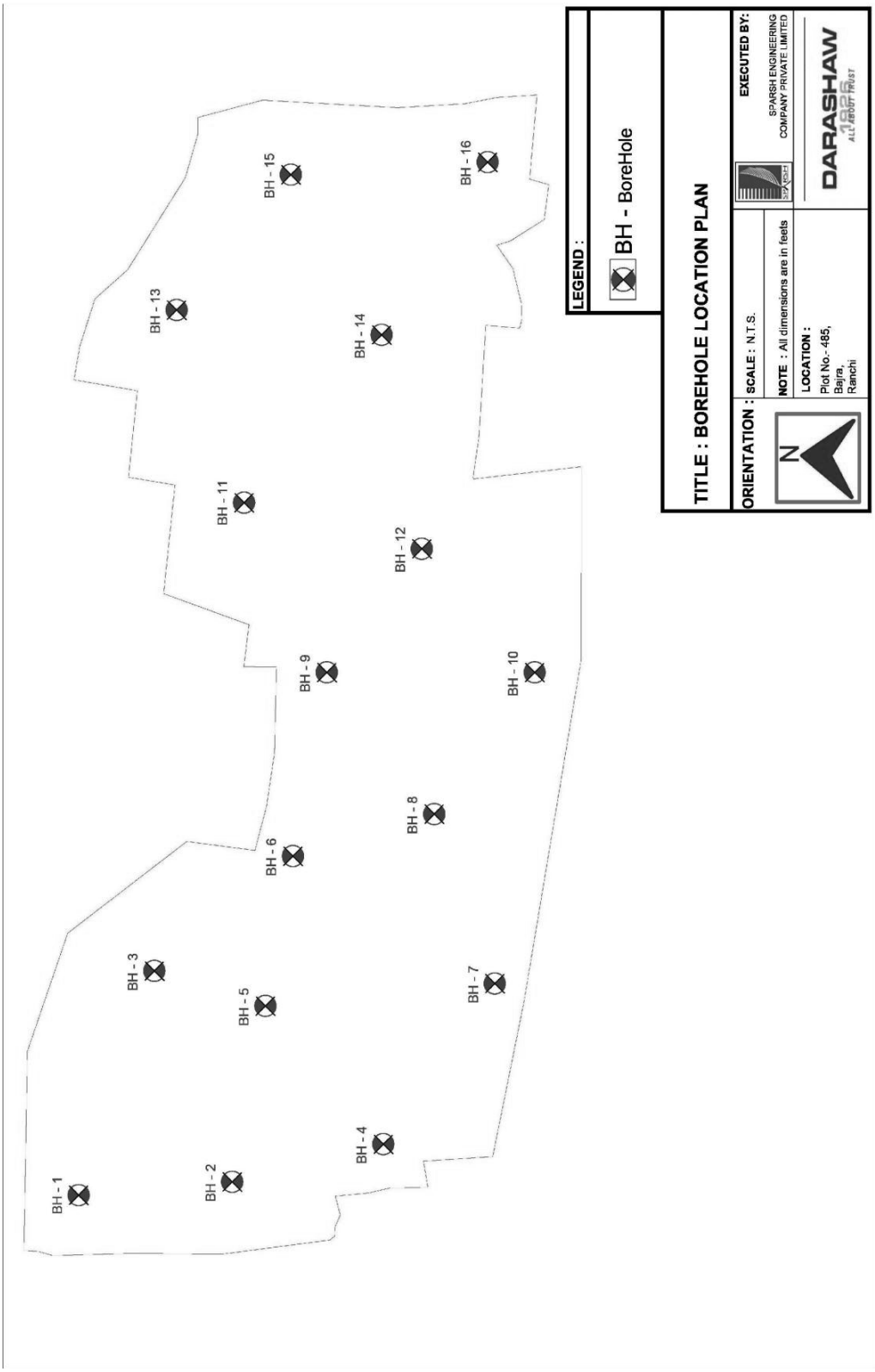
L/S : Left Side — R/S : Right Side

g_b : Bulk Density — NMC : Natural Moisture Content — W_P : Plastic Limit — S_G : Specific gravity — ϕ_u :Undrained Angle of Friction

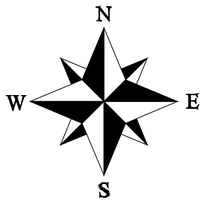
g_d : Dry Density — W_L : Liquid Limit — I_P : Plasticity Index — C_u : Undrain Cohesion — C_c :Coefficient of Consolidation

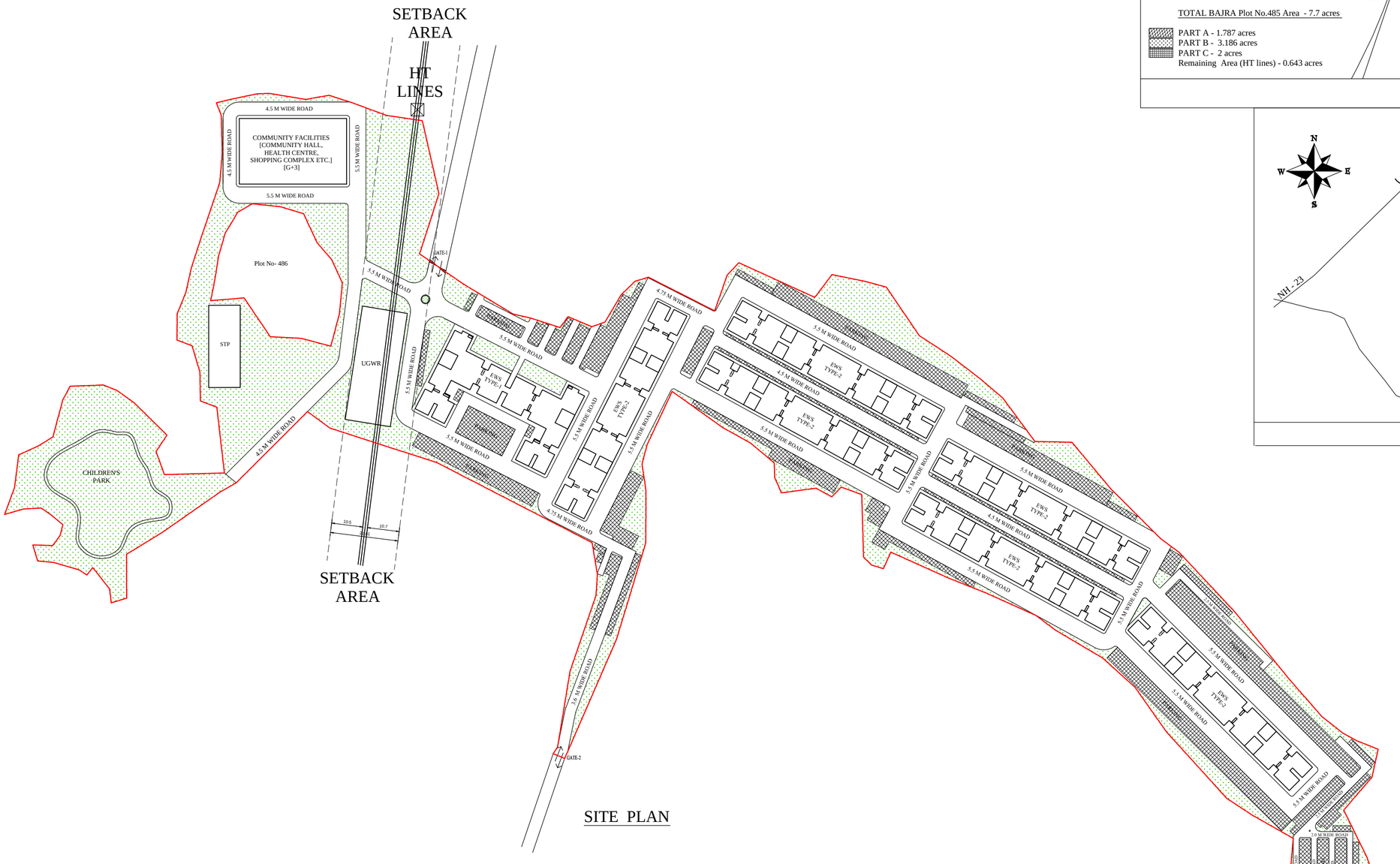
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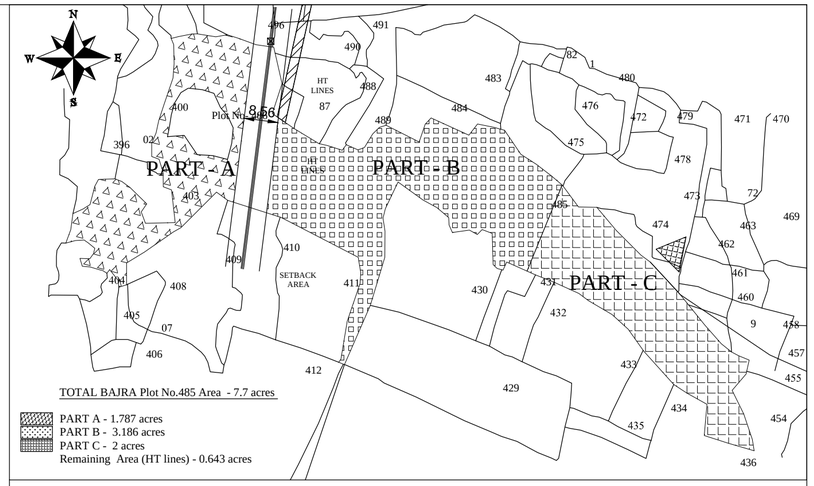
11. BORE HOLE LOCATION PLAN :



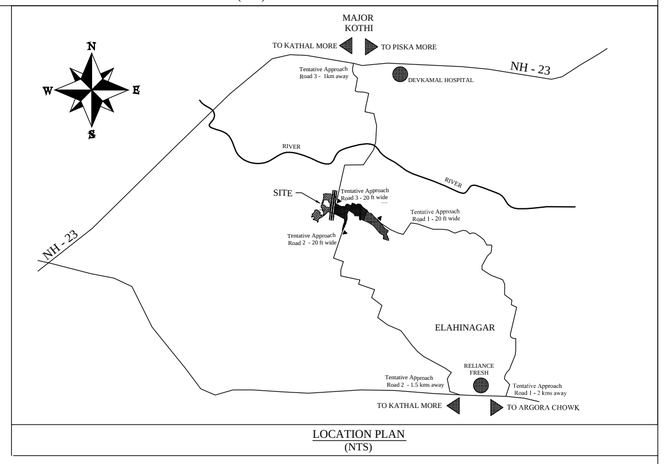
2.2.4 Layout Plan







KHASRA MAP
(NTS)



LOCATION PLAN
(NTS)

LEGEND:

- ---------- EWS BLOCK TYPE – 1
- ---------- EWS BLOCK TYPE – 2
- ---------- PARKING AREA
- ---------- GREEN AREA

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 13325 ALL SAINTS' TRUST

OFFICE OF ORGIN: RANCHI, PLOT NO.04 8th FLOOR MAHLI TOWER KANKE ROAD HATMA RANCHI-834008,JHARKHAND. TEL:0651-2547965

CLIENT: GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE: 06-JUN-2019

ENGINEERING CONSULTANT: DARASHAW & CO.PVT.LTD
HEAD OFFICE 12th FLOOR, REGENT CHAMBERS, NARIMAN POINT, MUMBAI - 400021

DRAWN: S.AHMAD

PROJECT: PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED: KALLOL DAS

TITLE: SITE PLAN

APPROVED: GEORGE THAMBI

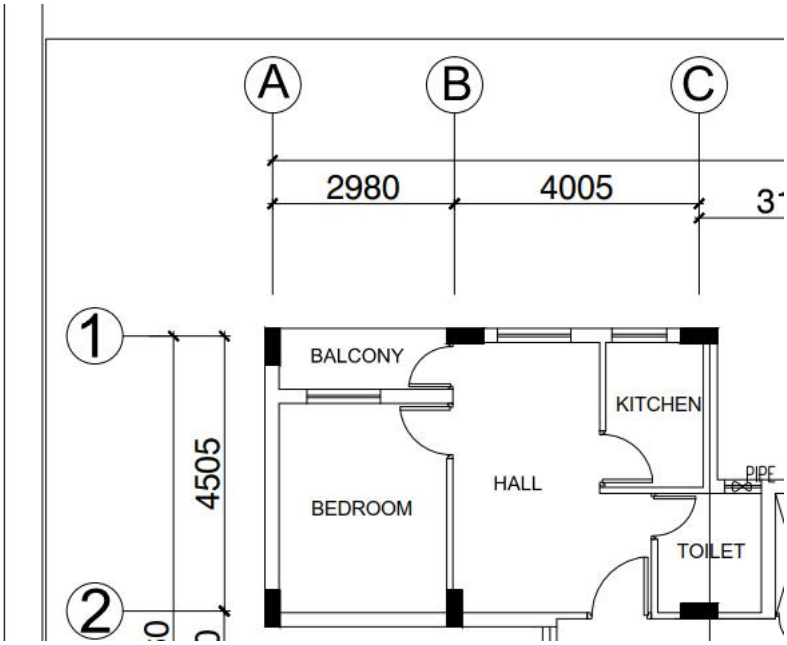
DRG. NO. DCPL/0460T/LHP/AR/WD/01

REV. P0

SCALE: NTS

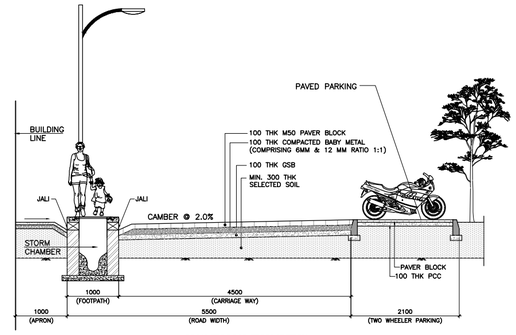
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2.2.5 Unit Plan

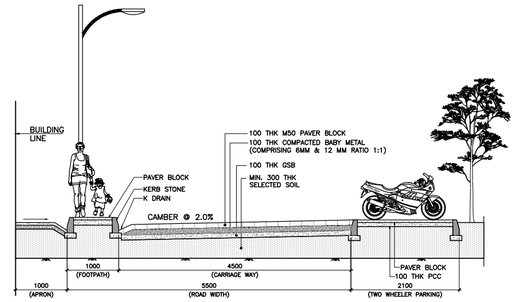


2.2.6 Floor Plans





5.5 M WIDE ROAD CROSS SECTION



5.5 M WIDE ROAD CROSS SECTION

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL UNDER ONE ROOF

OFFICE OF ORIGIN
RANCHI
FLAT NO.9A 4th FLOOR MARU TOWER KANKE ROAD HATWA RANCHI-834008,JHARKHAND. TEL:0651-2247985.

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS, NARIMAN POINT, MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
ROAD, CIRCULATION AND PARKING LAYOUT PLAN

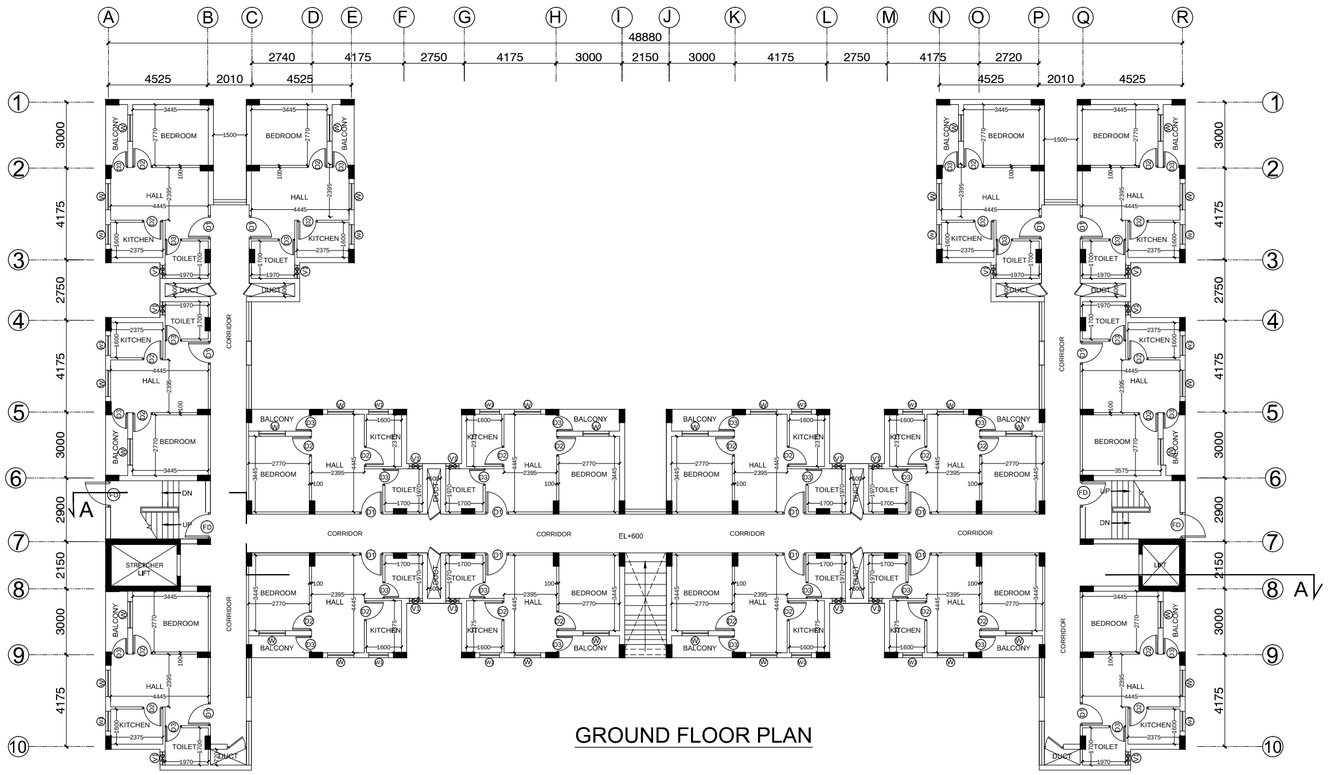
APPROVED
GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/AR/WD/02

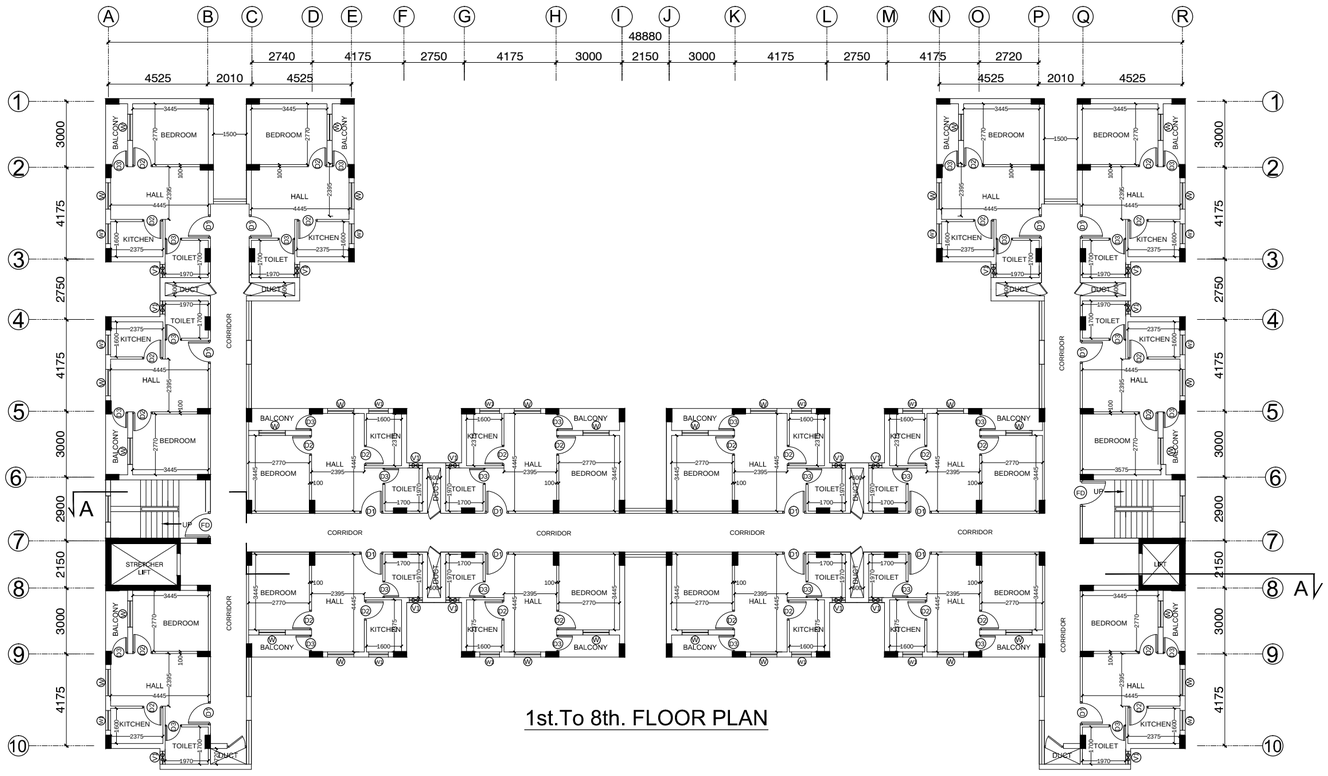
REV. P0

SCALE NTS

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GROUND FLOOR PLAN



1st.To 8th. FLOOR PLAN

OPENING SCHEDULE

S.NO.	ITEMS	SIZES W x H	LINTEL LVL.	TYPE
DOORS:-				
1.	D1	1050X2100	2100	SINGLE LEAF SOLID CORE TYPE WOODEN FLUSH DOOR WITH 35 MM THK. DOOR SHUTTER IN PRESSED STEEL FRAME
2.	D2	900X2100	2100	SINGLE LEAF SOLID CORE TYPE WOODEN FLUSH DOOR WITH 35 MM THK. DOOR SHUTTER IN PRESSED STEEL FRAME
3.	D3	750X2100	2100	SINGLE LEAF SOLID CORE TYPE WOODEN FLUSH DOOR WITH 35 MM THK. DOOR SHUTTER IN PRESSED STEEL FRAME
4.	D4	1200X2100	2100	MS GRILL DOOR AS PER DETAIL
5.	FD	1200X2100	2100	FIRE DOOR
WINDOWS:-				
6.	W	1200X1200	2100	TWO TRACK FULLY GLAZED ALUMINIUM SLIDING WINDOW IN POWDER COATED ALUMINIUM FRAME
7.	W1	1200X1050	2100	TWO TRACK FULLY GLAZED ALUMINIUM SLIDING WINDOW IN POWDER COATED ALUMINIUM FRAME
8.	EX1	350 DIA.	BOTTOM OF EXHAUST OPENING AT TOP OF LINTEL	EXHAUST FAN
VENTILATORS:-				
9.	V	600 X 750	2100	ALUMINIUM VENTILATOR WITH GLASS LOUVER & EXHAUST FAN AS PER DETAIL

NOTES:

1 ALL DIMENSIONS ARE IN MM & ONLY FIGURED DIMENSIONS ARE TO BE FOLLOWED

2 IN CASE OF DISCREPANCIES, IF ANY, CONTRACTOR SHOULD IMMEDIATELY INFORM THE MATTER TO THE ENGINEER IN CHARGE / DESIGN OFFICE, BEFORE PROCEEDING ANY WORK ON THAT PART

3 LEVEL (±) CORRESPONDS TO ROAD CROWN LEVEL OF ROAD ABUTTING THE SITE

4 ALL FREE ENDS OF CHAJJAS AND SLAB PROJECTION SHALL HAVE 25 WIDE x 15 DEEP DRIP COURSE

5 ALL 110 THK BRICK WALL WILL BE REINFORCED BRICKWORK WITH NOMINAL REINFORCEMENT AT EVERY THREE LAYERS

6 CEMENT MORTAR IN BRICK MASONRY SHALL BE
a) 1:6 FOR 230 THK BRICK WALLS
b) 1:4 FOR 110 THK BRICK WALLS

7 1000 HIGH, 110x110 RCC MULLIONS SHOULD BE CONSTRUCTED IN 110 THK PARAPET WALLS AT BEAM LOCATIONS

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.

2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 13625 ALL SAFARI TRUST

OFFICE OF ORIGIN: RANCHI, PLOT NO.04 4th FLOOR MAIN TOWER KHARE ROAD HATMA RANCHI-834008,JHARKHAND. TEL:0651-2247885

CLIENT: GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE: 06-JUN-2019

ENGINEERING CONSULTANT: DARASHAW & CO.PVT.LTD
HEAD OFFICE 12th FLOOR, REGENT CHAMBERS, NARIMAN POINT, MUMBAI - 400021

DRAWN: S.AHMAD

PROJECT: PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED: KALLOL DAS

TITLE: EWS TYPE - 1, FLOOR PLANS AND SCHEDULE OF OPENINGS

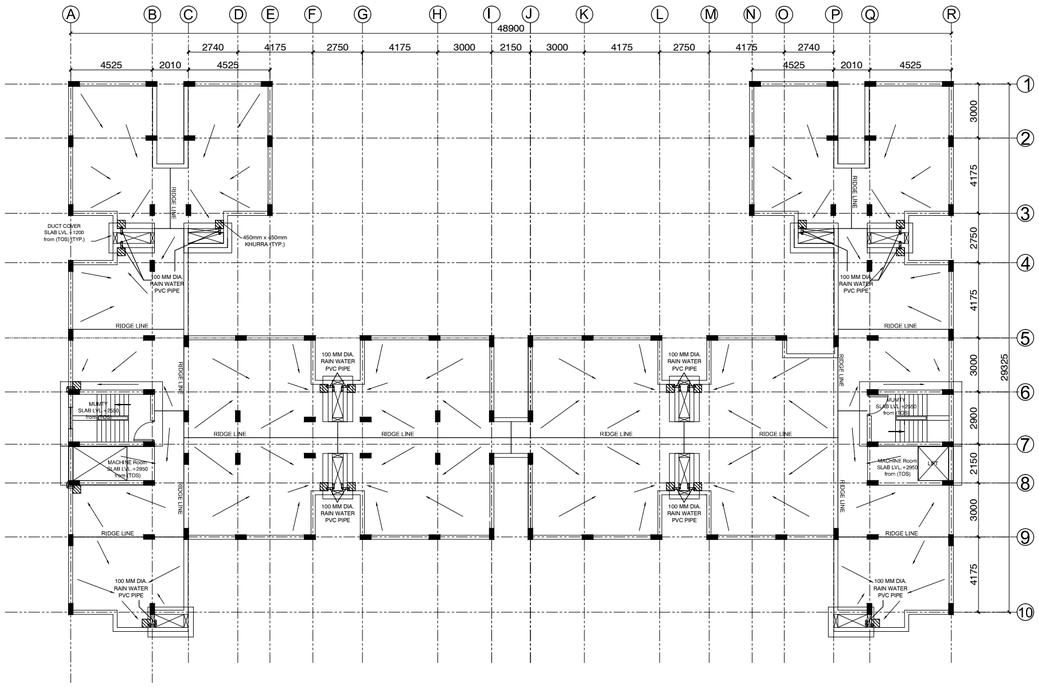
APPROVED: GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/AR/WD/03

REV. P0

SCALE 1:100

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TERRACE FLOOR PLAN

NOTES:

1 ALL DIMENSIONS ARE IN MM & ONLY FIGURED DIMENSIONS ARE TO BE FOLLOWED

2 IN CASE OF DISCREPANCIES, IF ANY, CONTRACTOR SHOULD IMMEDIATELY INFORM THE MATTER TO THE ENGINEER IN CHARGE / DESIGN OFFICE, BEFORE PROCEEDING ANY WORK ON THAT PART

3 LEVEL (±) CORRESPONDS TO ROAD CROWN LEVEL OF ROAD ABUTTING THE SITE

4 ALL FREE ENDS OF CHAJJAS AND SLAB PROJECTION SHALL HAVE 25 WIDE x 15 DEEP DRIP COURSE

5 ALL 110 THK BRICK WALL WILL BE REINFORCED BRICKWORK WITH NOMINAL REINFORCEMENT AT EVERY THREE LAYERS

6 CEMENT MORTAR IN BRICK MASONRY SHALL BE
a) 1:6 FOR 230 THK BRICK WALLS
b) 1:4 FOR 110 THK BRICK WALLS

7 1000 HIGH, 110x110 RCC MULLIONS SHOULD BE CONSTRUCTED IN 110 THK PARAPET WALLS AT BEAM LOCATIONS

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.

2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL GROUP WORK

OFFICE OF ORIGIN
RANCHI
FLAT NO.6A 6th FLOOR MARU TOWER
KANKE ROAD HATMA
RANCHI-834008,JHARKHAND.
TEL:0651-2247666

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
EWS TYPE - 1, TERRACE FLOOR PLAN

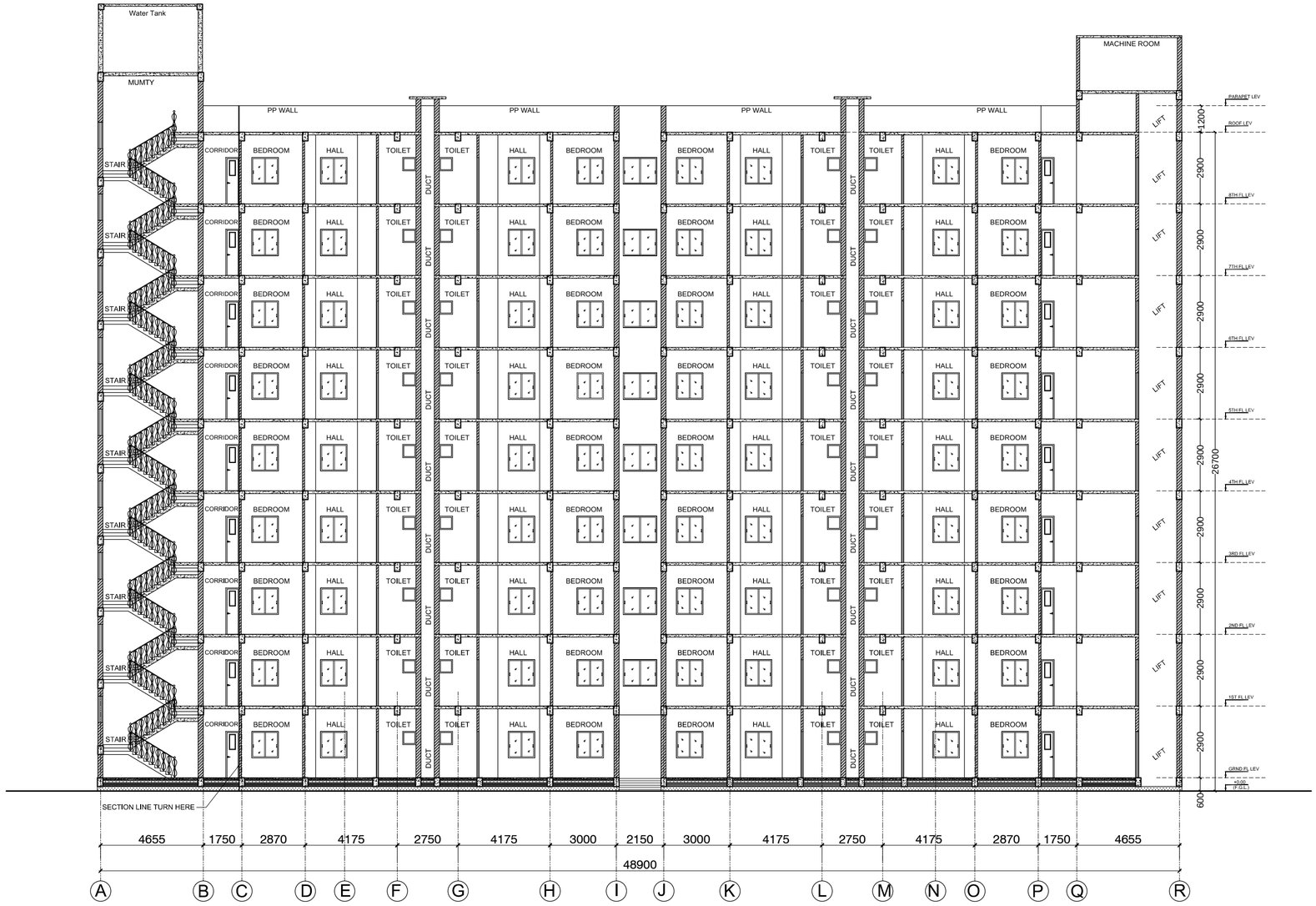
APPROVED
GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/AR/WD/04

REV. P0

SCALE 1:100

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SECTION A-A

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL SMART THINK IT

OFFICE OF ORIGIN
RANCHI
PLOT NO.04 6th FLOOR MAIN) TOWER
KANKE ROAD,HATMA
RANCHI-834008,JHARKHAND.
TEL:0651-2242960.

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
EWS TYPE - 1, SECTION

APPROVED
GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/AR/WD/05

REV.
P0

SCALE
1:100

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FRONT ELEVATION

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
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DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW
ALL SMART NOW!

OFFICE OF ORIGIN
RANCHI
FLAT NO.GA 6th FLOOR MARU TOWER
KANKE ROAD HATMA
RANCHI-834008,JHARKHAND.
TEL:0651-2247985

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION,
DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
EWS TYPE - 1, ELEVATION

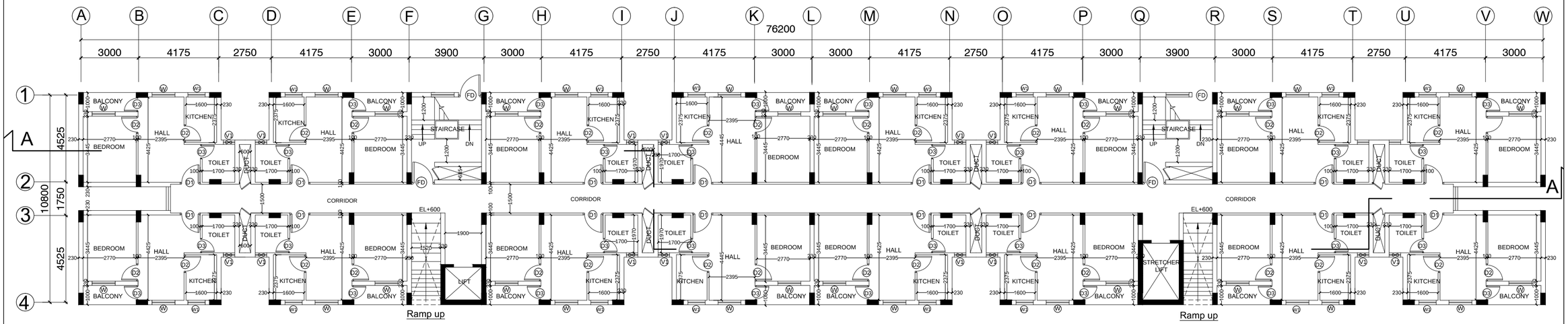
APPROVED
GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/AR/WD/06

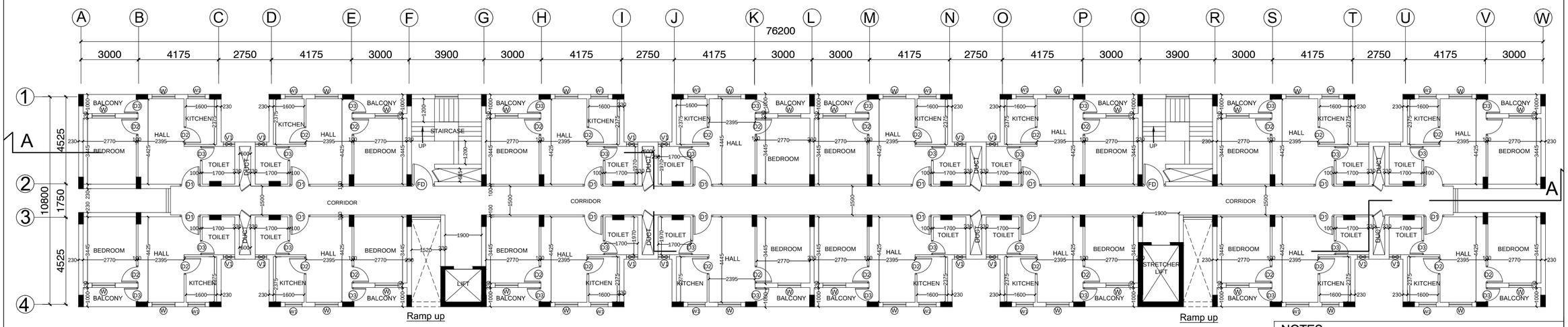
REV.
P0

SCALE
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GROUND FLOOR PLAN



1st.To 8th. FLOOR PLAN

OPENING SCHEDULE

S.NO.	ITEMS	SIZES W x H	LINTEL LVL.	TYPE
DOORS:-				
1.	D1	1050X2100	2100	SINGLE LEAF SOLID CORE TYPE WOODEN FLUSH DOOR WITH 35 MM THK. DOOR SHUTTER IN PRESSED STEEL FRAME
2.	D2	900X2100	2100	SINGLE LEAF SOLID CORE TYPE WOODEN FLUSH DOOR WITH 35 MM THK. DOOR SHUTTER IN PRESSED STEEL FRAME
3.	D3	750X2100	2100	SINGLE LEAF SOLID CORE TYPE WOODEN FLUSH DOOR WITH 35 MM THK. DOOR SHUTTER IN PRESSED STEEL FRAME
4.	D4	1200X2100	2100	MS GRILL DOOR AS PER DETAIL
5.	FD	1200X2100	2100	FIRE DOOR
WINDOWS:-				
6.	W	1200X1200	2100	TWO TRACK FULLY GLAZED ALUMINIUM SLIDING WINDOW IN POWDER COATED ALUMINIUM FRAME
7.	W1	1200X1050	2100	TWO TRACK FULLY GLAZED ALUMINIUM SLIDING WINDOW IN POWDER COATED ALUMINIUM FRAME
8.	EX1	350 DIA.	BOTTOM OF EXHAUST OPENING AT TOP OF LINTEL	EXHAUST FAN
VENTILATORS:-				
9.	V	600 X 750	2100	ALUMINIUM VENTILATOR WITH GLASS LOUVER & EXHAUST FAN AS PER DETAIL

NOTES:

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3 LEVEL (±) CORRESPONDS TO ROAD CROWN LEVEL OF ROAD ABUTTING THE SITE

4 ALL FREE ENDS OF CHAJJAS AND SLAB PROJECTION SHALL HAVE 25 WIDE x 15 DEEP DRIP COURSE

5 ALL 110 THK BRICK WALL WILL BE REINFORCED BRICKWORK WITH NOMINAL REINFORCEMENT AT EVERY THREE LAYERS

6 CEMENT MORTAR IN BRICK MASONRY SHALL BE
a) 1:6 FOR 230 THK BRICK WALLS
b) 1:4 FOR 110 THK BRICK WALLS

7 1000 HIGH, 110x110 RCC MULLIONS SHOULD BE CONSTRUCTED IN 110 THK PARAPET WALLS AT BEAM LOCATIONS

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL SAFARI PUNIT

OFFICE OF ORIGIN
RANCHI
PLOT NO.04, 9th FLOOR MAIN1 TOWER KANKE ROAD,HATMA RANCHI-834008,JHARKHAND. TEL:0651-2247855

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD
HEAD OFFICE
12th FLOOR, REGENT CHAMBERS, NARIMAN POINT, MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
EWS TYPE - 2, FLOOR PLANS AND SCHEDULE OF OPENINGS

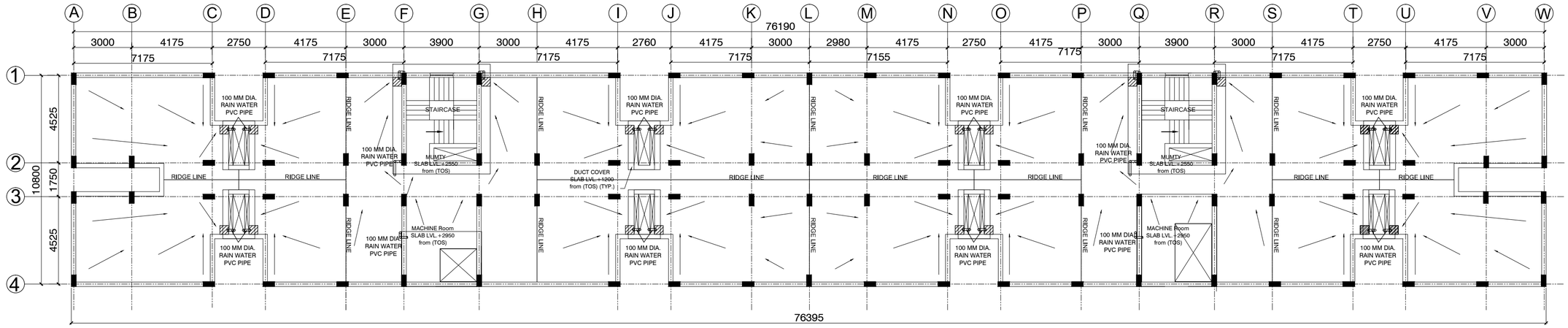
APPROVED
GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/AR/WD/07

REV. P0

SCALE 1:100

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TERRACE FLOOR PLAN

NOTES:

1 ALL DIMENSIONS ARE IN MM & ONLY FIGURED DIMENSIONS ARE TO BE FOLLOWED

2 IN CASE OF DISCREPANCIES, IF ANY, CONTRACTOR SHOULD IMMEDIATELY INFORM THE MATTER TO THE ENGINEER IN CHARGE / DESIGN OFFICE, BEFORE PROCEEDING ANY WORK ON THAT PART

3 LEVEL (±) CORRESPONDS TO ROAD CROWN LEVEL OF ROAD ABUTTING THE SITE

4 ALL FREE ENDS OF CHAJJAS AND SLAB PROJECTION SHALL HAVE 25 WIDE x 15 DEEP DRIP COURSE

5 ALL 110 THK BRICK WALL WILL BE REINFORCED BRICKWORK WITH NOMINAL REINFORCEMENT AT EVERY THREE LAYERS

6 CEMENT MORTAR IN BRICK MASONRY SHALL BE
a) 1:6 FOR 230 THK BRICK WALLS
b) 1:4 FOR 110 THK BRICK WALLS

7 1000 HIGH, 110x110 RCC MULLIONS SHOULD BE CONSTRUCTED IN 110 THK PARAPET WALLS AT BEAM LOCATIONS

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.

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DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL THE WAY TODAY

OFFICE OF ORIGIN
RANCHI
FLAT NO.6A, 6th FLOOR MAHLI TOWER
KANKE ROAD HATMA
RANCHI-834008,JHARKHAND.
TEL:0651-2347985.

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
EWS TYPE - 2, TERRACE FLOOR PLAN

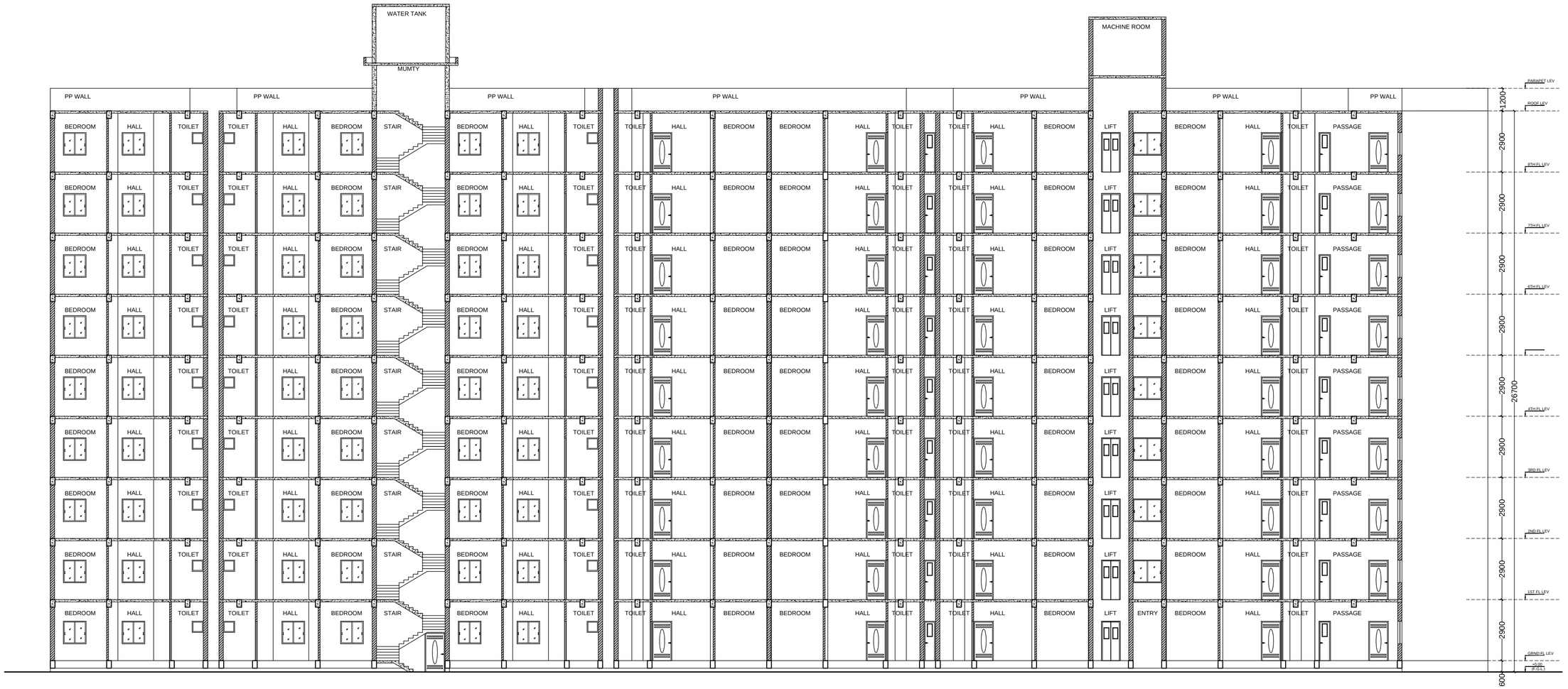
APPROVED
GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/AR/WD/08

REV. P0

SCALE 1:100

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SECTION A - A

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL ROADS FROM

OFFICE OF ORIGIN
RANCHI
FLAT NO.6A 6th FLOOR MAIN) TOWER
KANKE ROAD HATMA
RANCHI-834008,JHARKHAND.
TEL:0651-2347985

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
EWS TYPE - 2, SECTION

APPROVED
GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/AR/WD/09

REV.
P0

SCALE
1:100

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FRONT ELEVATION

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 13275 ALL GENIUS UNDER

OFFICE OF ORIGIN: RANCHI
PLAT NO.6A 4th FLOOR MAIN TOWER KANKE ROAD PATRA RANCHI-834008,JHARKHAND TEL.0651-2242566

CLIENT: GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE: 06-JUN-2019

ENGINEERING CONSULTANT: DARASHAW & CO.PVT.LTD
HEAD OFFICE 12th FLOOR, REGENT CHAMBERS, NARIMAN POINT, MUMBAI - 400021

DRAWN: S.AHMAD

PROJECT: PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED: KALLOL DAS

TITLE: EWS TYPE - 2, ELEVATION

APPROVED: GEORGE THAMBI

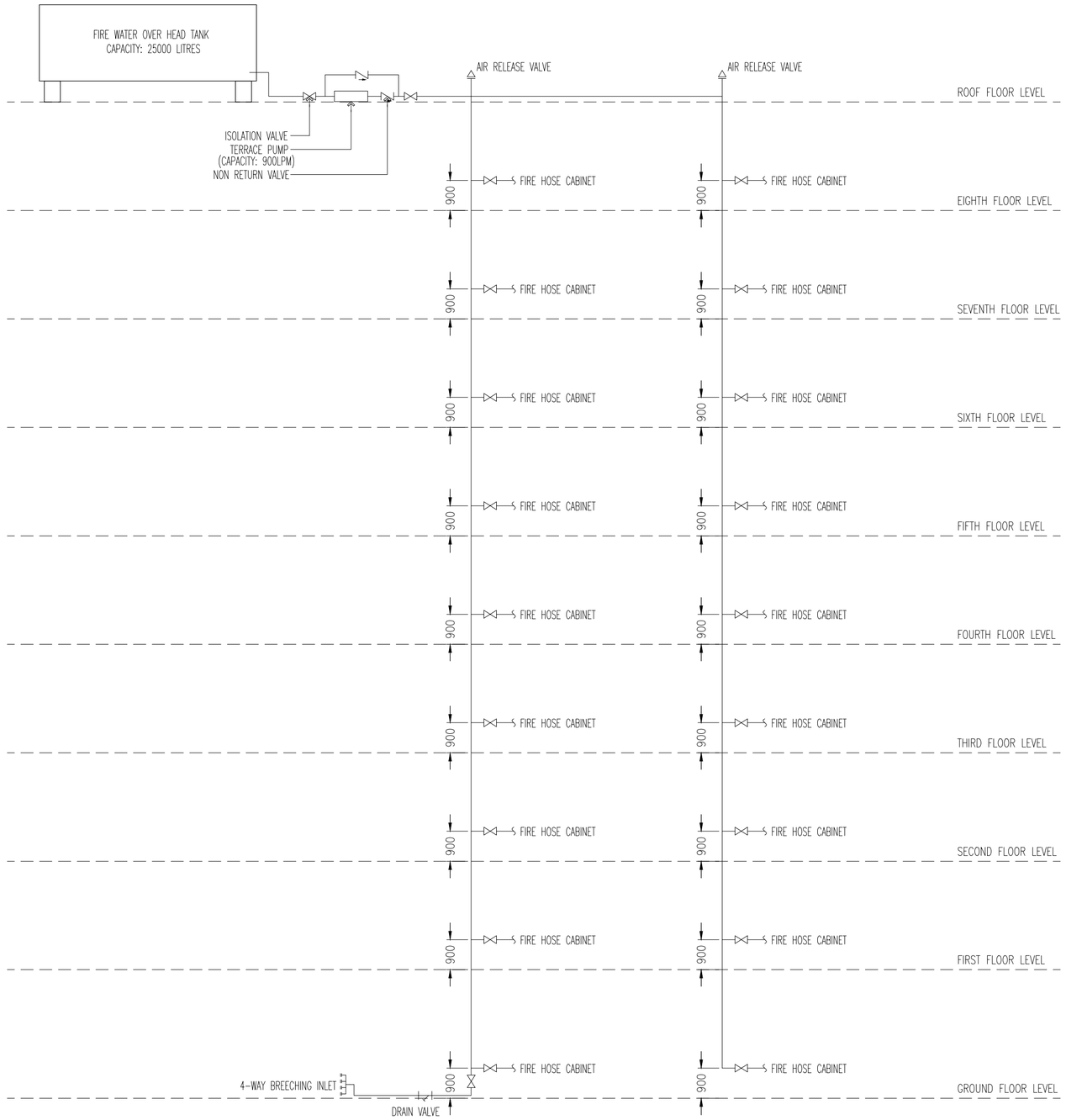
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REV. P0

SCALE 1:100

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2.2.7 Physical Infrastructure Drawings



TYPICAL FLAT BLOCK FIRE PROTECTION SCHEMATIC DIAGRAM

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW — ALL ABOUT TRUST

JUIDCO — JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

OFFICE OF ORIGIN
RANCHI
FLAT NO.A/6, 4TH FLOOR, SWARJ TOWER
HATWA KAMKE ROAD
RANCHI-834008, JHARKHAND.
TEL:091-1-2547965.

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

PURPOSE:

DATE:
03-MAY-2019

ENGINEERING CONSULTANT:
DARASHAW & COMPANY PRIVATE LIMITED

HEAD OFFICE
12th FLOOR,
REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN:
S. Ahmed

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION,
DPR AND PMC UNDER PMAY AHP/LHP

CHECKED:
Kallol Das

TITLE:
SCHEMATIC DIAGRAM
FIRE PROTECTION LAYOUT

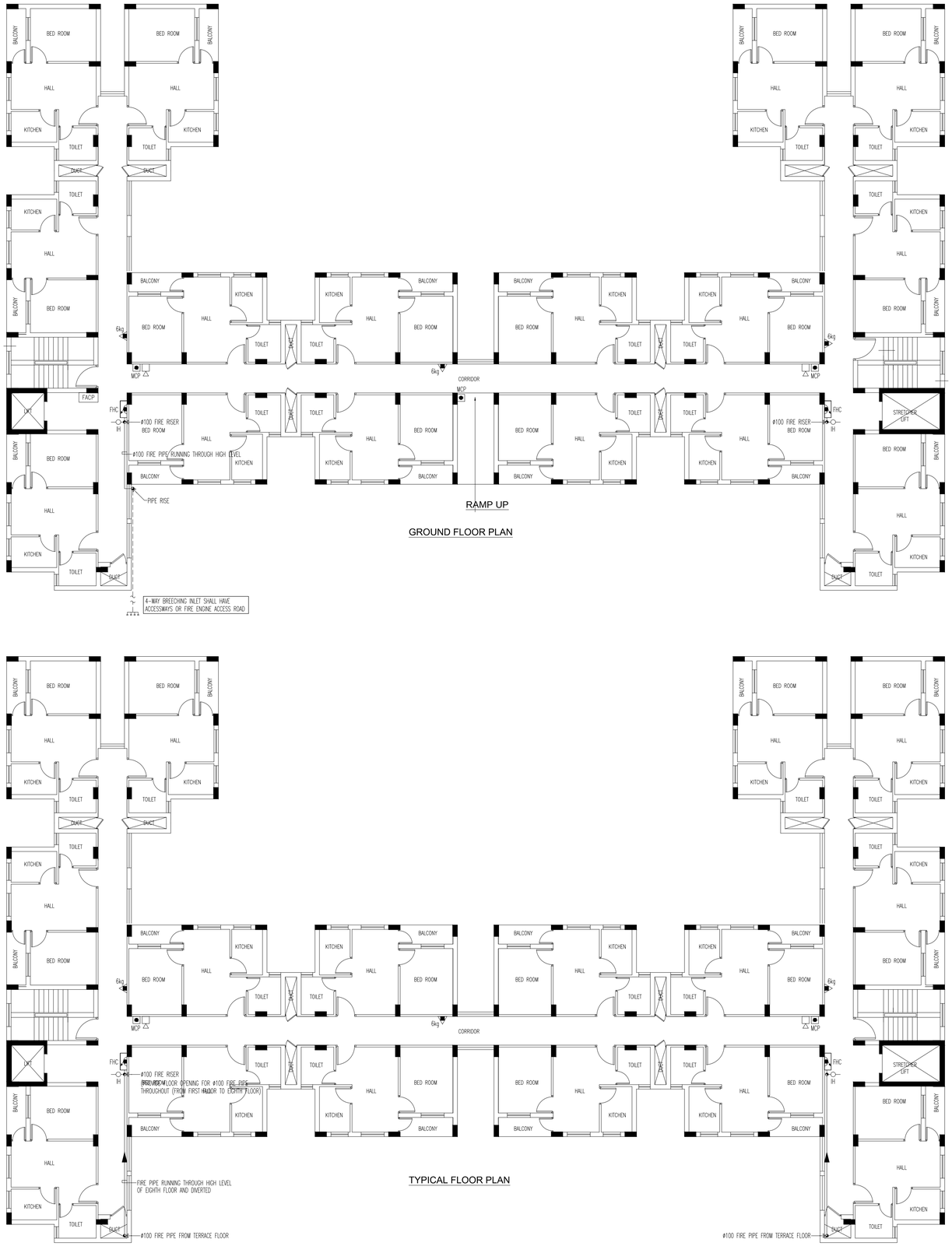
APPROVED:
George Thambi

DRG. NO. - DCPL/0460T/LHP/SR/WD/11

REV.
P0

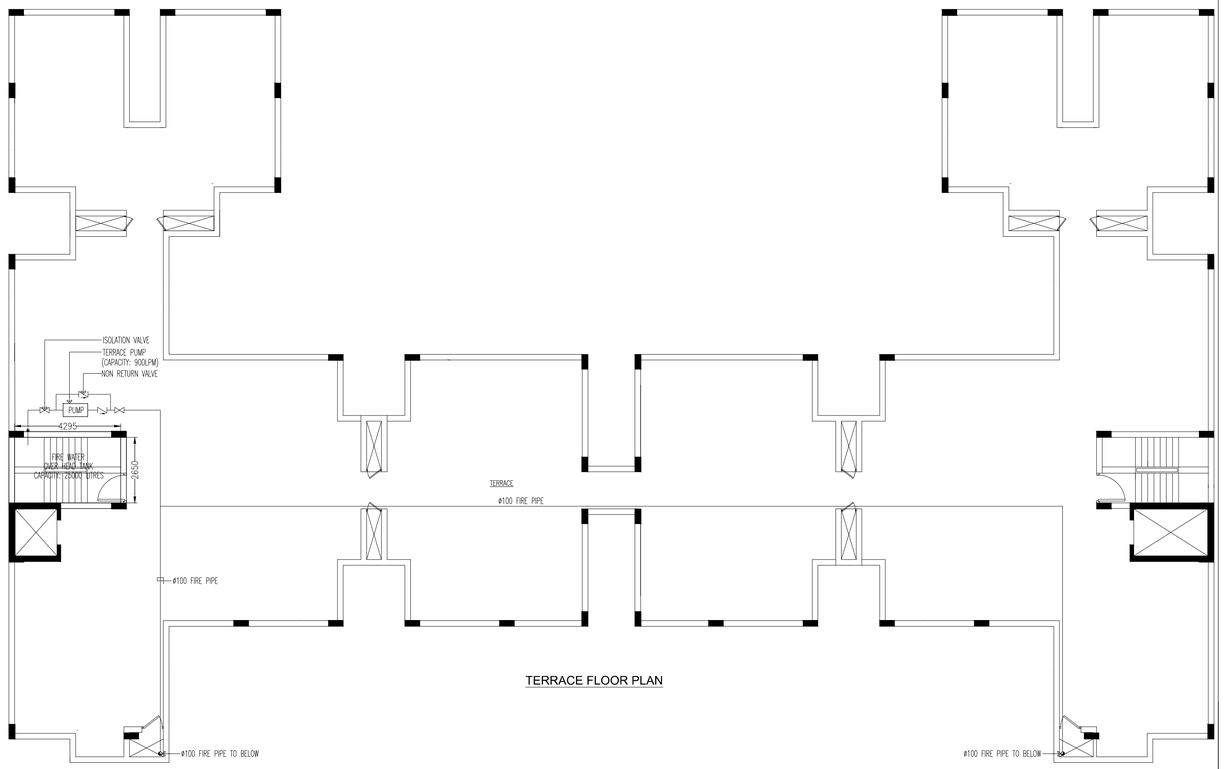
SCALE:
1:100 UN

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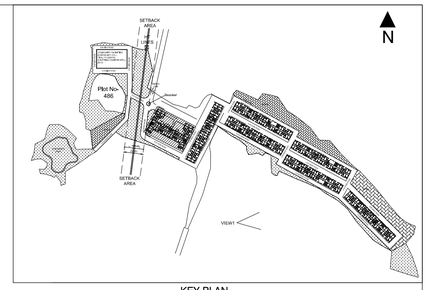


GROUND FLOOR PLAN

TYPICAL FLOOR PLAN



TERRACE FLOOR PLAN



KEY PLAN
(NTS)

LEGENDS:

SN	SYMBOL	DESCRIPTION
01	———	FIRE PIPE LINE
02	– – – –	FIRE PIPE LINE (UNDER GROUND)
03		FIRE PIPE RISER
04	FHC	FIRE HOSE CABINET (FHC)
05	IH	INTERNAL HYDRANT (IH)
06	6kg	DRY CHEMICAL EXTINGUISHER – ABC TYPE
07	FACP	FIRE ALARM CONTROL PANEL
08		MANUAL CALL POINT
09		ADDRESSABLE HORN
10		4-WAY BREECHING INLET

NOTES:

1 ALL DIMENSIONS ARE IN MM & ONLY FIGURED DIMENSIONS ARE TO BE FOLLOWED

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW
ALL ABOUT TRUST

JDCO
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

OFFICE OF ORIGIN
RANCHI
FLAT NO.4A, 4TH FLOOR MARU TOWER HATMA KANKE ROAD RANCHI-834008,JHARKHAND. TEL;2661-2547665,

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

PURPOSE:

DATE:
03-MAY-2019

ENGINEERING CONSULTANT:
DARASHAW & COMPANY PRIVATE LIMITED

HEAD OFFICE
12th FLOOR,
REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN:
S. Ahmed

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION,
DPR AND PMC UNDER PMAY AHP/LHP

CHECKED:
Kallol Das

TITLE:
FLAT BLOCK - TYPE 1
FLOOR PLANS
FIRE PROTECTION LAYOUT

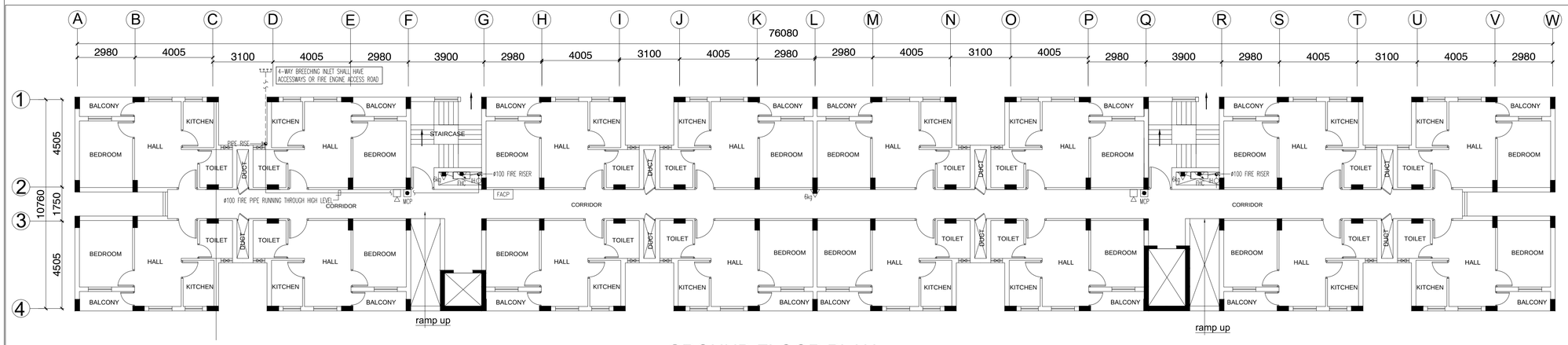
APPROVED:
George Thambi

DRG. NO. - DCPL/0460T/LHP/SR/WD/12

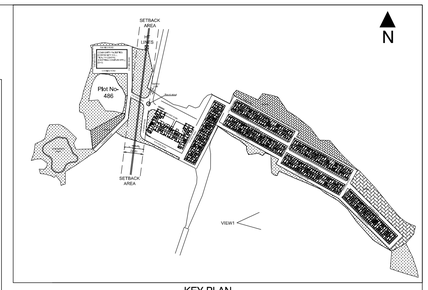
REV.
P0

SCALE:
1:125 UN

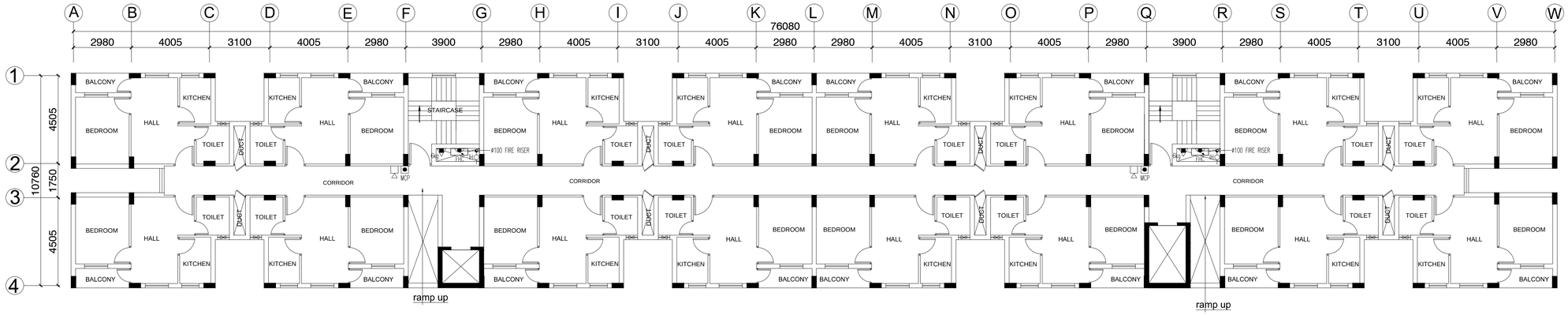
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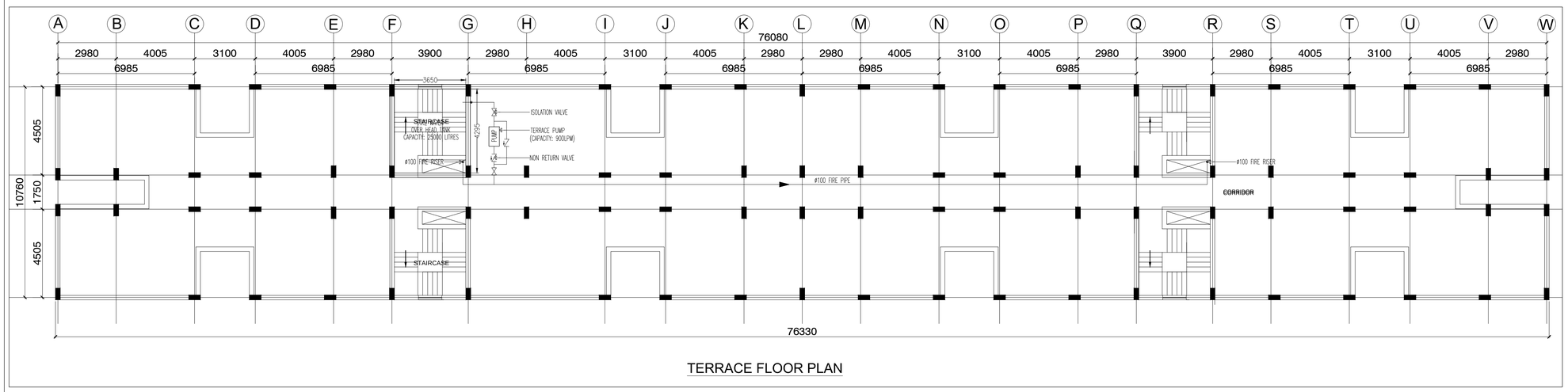
GROUND FLOOR PLAN



KEY PLAN
(NTS)



TYPICAL FLOOR PLAN



TERRACE FLOOR PLAN

LEGENDS:

SN	SYMBOL	DESCRIPTION
01	———	FIRE PIPE LINE
02	– – – –	FIRE PIPE LINE (UNDER GROUND)
03		FIRE PIPE RISER
04	FHC	FIRE HOSE CABINET (FHC)
05		INTERNAL HYDRANT (IH)
06	DCP	DRY CHEMICAL EXTINGUISHER – ABC TYPE
07	FACP	FIRE ALARM CONTROL PANEL
08		MANUAL CALL POINT
09		ADDRESSABLE HORN
10		4-WAY BREECHING INLET

NOTES:

1 ALL DIMENSIONS ARE IN MM & ONLY FIGURED DIMENSIONS ARE TO BE FOLLOWED

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1885 ALL ABOUT TRUST

IDCO Innovative Urban Environment

OFFICE OF ORIGIN
RANCHI
FLAT NO.-6A, 6TH FLOOR MARUTI TOWER
PATNA KANKE ROAD
RANCHI-834008,JHARKHAND
TEL.0651-2547665,

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

ENGINEERING CONSULTANT:
DARASHAW & COMPANY PRIVATE LIMITED
HEAD OFFICE
12th FLOOR,
REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION,
DPR AND PMC UNDER PMAY AHP/LHP

TITLE:
FLAT BLOCK - TYPE 2
FLOOR PLANS
FIRE PROTECTION LAYOUT

PURPOSE:

DATE: 06-JUN-2019

DRAWN: S. Ahmed

CHECKED: Kallol Das

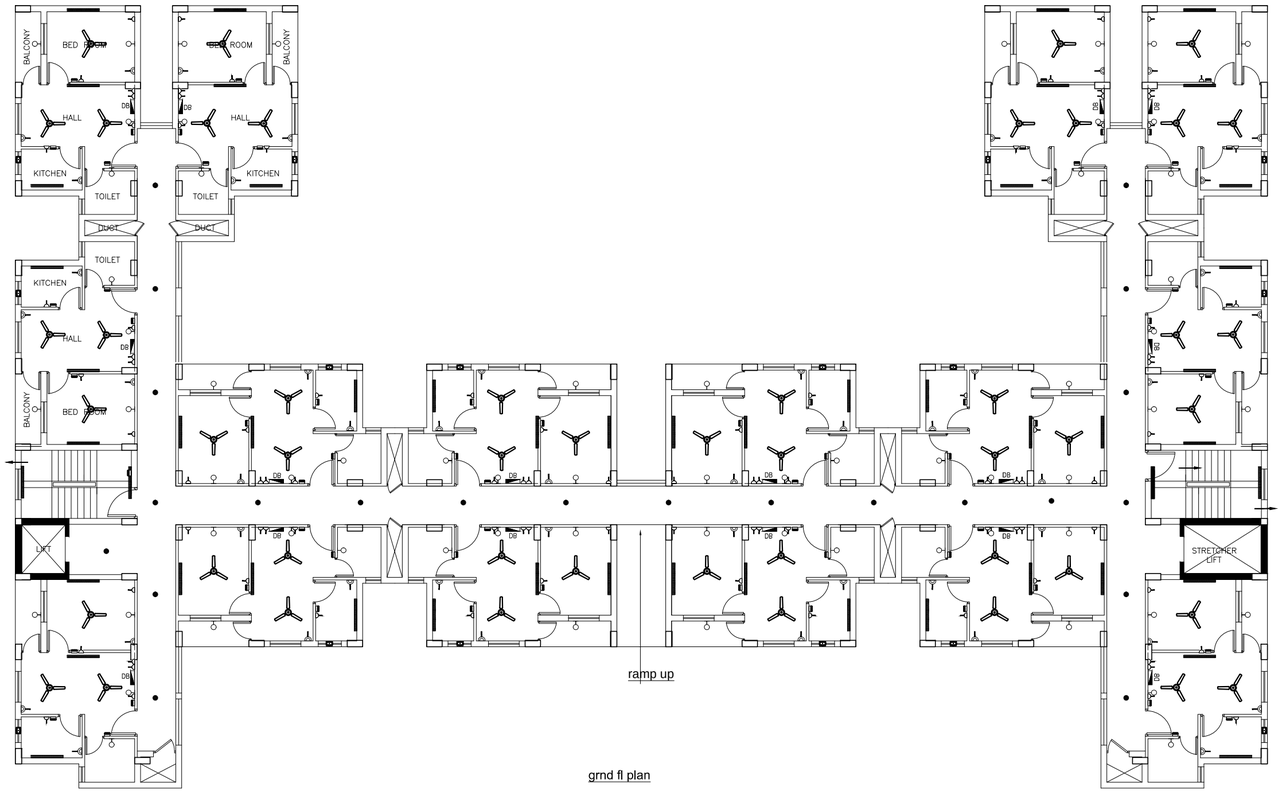
APPROVED: George Thambi

DRG. NO. - DCPL/0460T/LHP/SR/WD/13

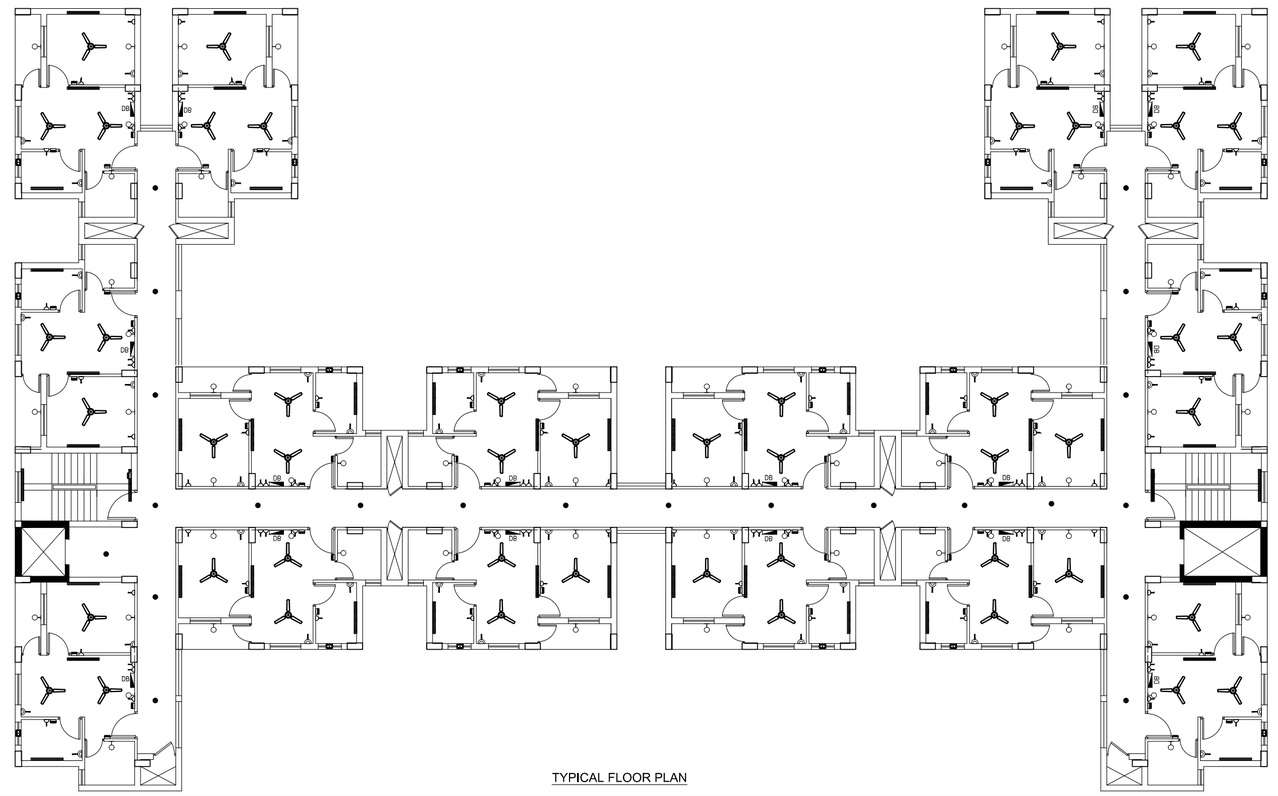
REV. P0

SCALE: 1:125 UN

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grnd fl plan



TYPICAL FLOOR PLAN

LEGEND

Sl.No	SYMBOL	DESCRIPTION
1		18W LED BATTEN
2		WALL LIGHT POINT
3		12W SURFACE MOUNTED LED DOWN LIGHT
4		CEILING FAN
5		250mm DIA EXHAUST FAN WITH LOUVER
6		SWITCH BOARD
7		6A SWITCH SOCKET
8		6/16A SWITCH SOCKET
10		DISTRIBUTION BOARD

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1922 ALL ABOUT TRUST

OFFICE OF ORIGIN
RANCHI
FLAT NO.6A 6th FLOOR MARU TOWER
KANKE ROAD HATMA
RANCHI-834008,JHARKHAND.
TEL.:0651-2547995.

CLIENT:
GOVERNMENT OF JHARKHAND
URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY

CHECKED
KD

TITLE:
EWS TYPE - 1 -LIGHTING LAYOUT
GROUND & TYPICAL FLOOR PLAN

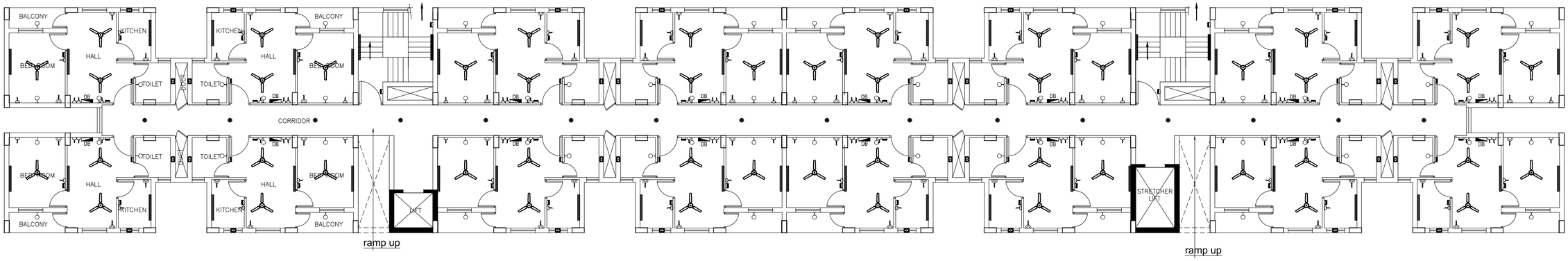
APPROVED
GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/SR/WD/14

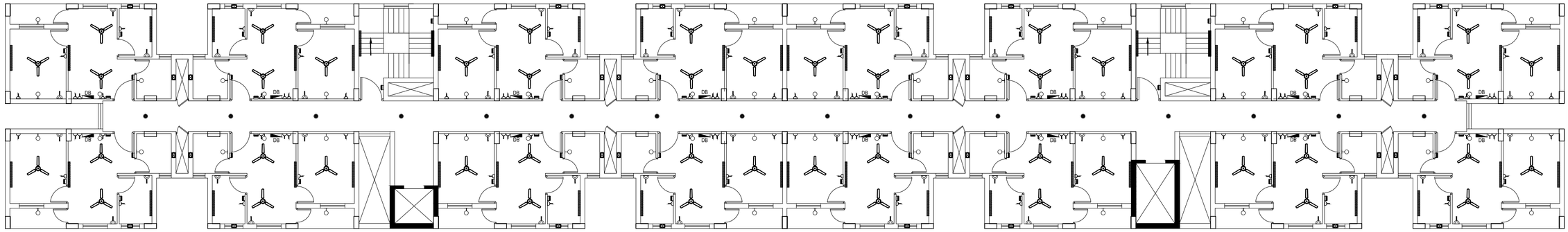
REV. P0

SCALE
NTS

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grnd fl plan



TYPICAL FLOOR PLAN

LEGEND

Sl.No	SYMBOL	DESCRIPTION
1		18W LED BATTEN
2		WALL LIGHT POINT
3		12W SURFACE MOUNTED LED DOWN LIGHT
4		CEILING FAN
5		250mm DIA EXHAUST FAN WITH LOUVER
6		SWITCH BOARD
7		6A SWITCH SOCKET
8		6/16A SWITCH SOCKET
10		DISTRIBUTION BOARD

NOTES :-

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2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL ABOUT TRUST

JUIDCO

OFFICE OF ORIGIN
RANCHI
FLAT NO.6A 6th FLOOR MARU TOWER
KANKE ROAD HATMA
RANCHI-834008,JHARKHAND.
TEL.0651-2547665.

CLIENT:
GOVERNMENT OF JHARKHAND
URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED

DATE
JUNE-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY

CHECKED
KD

TITLE:
EWS TYPE-2 - LIGHTING LAYOUT
GROUND & TYPICAL FLOOR PLAN

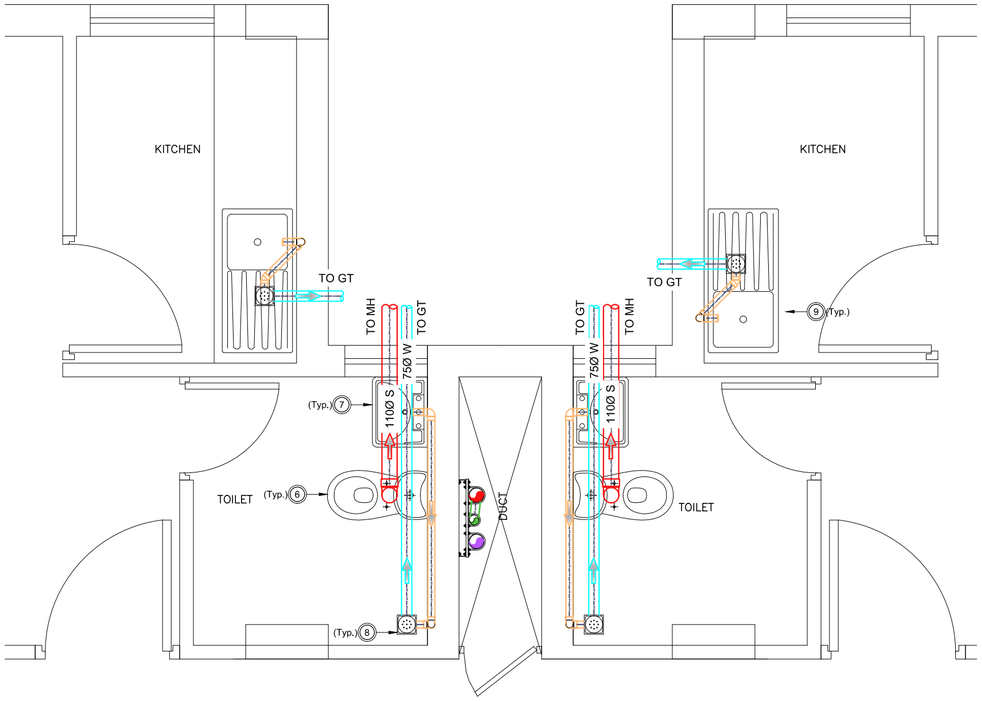
APPROVED
GEORGE THAMBI

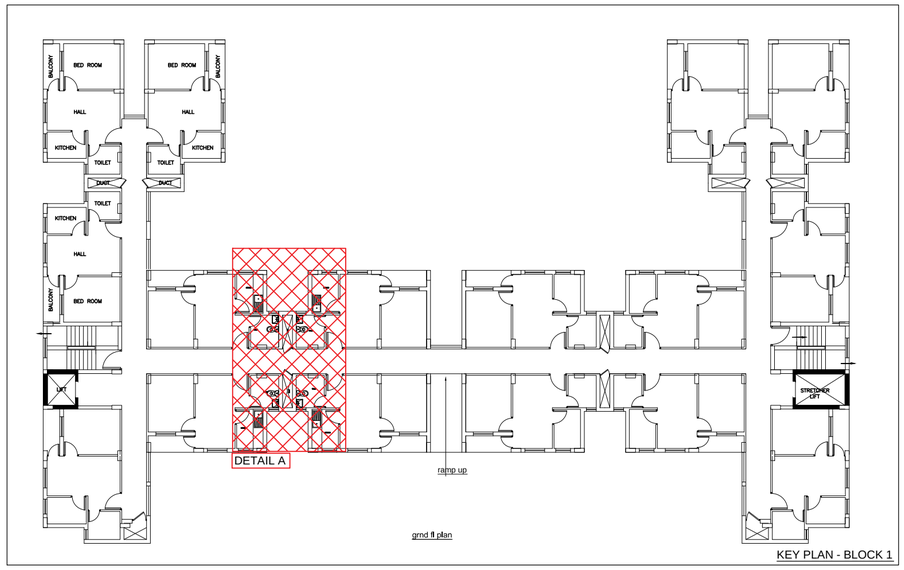
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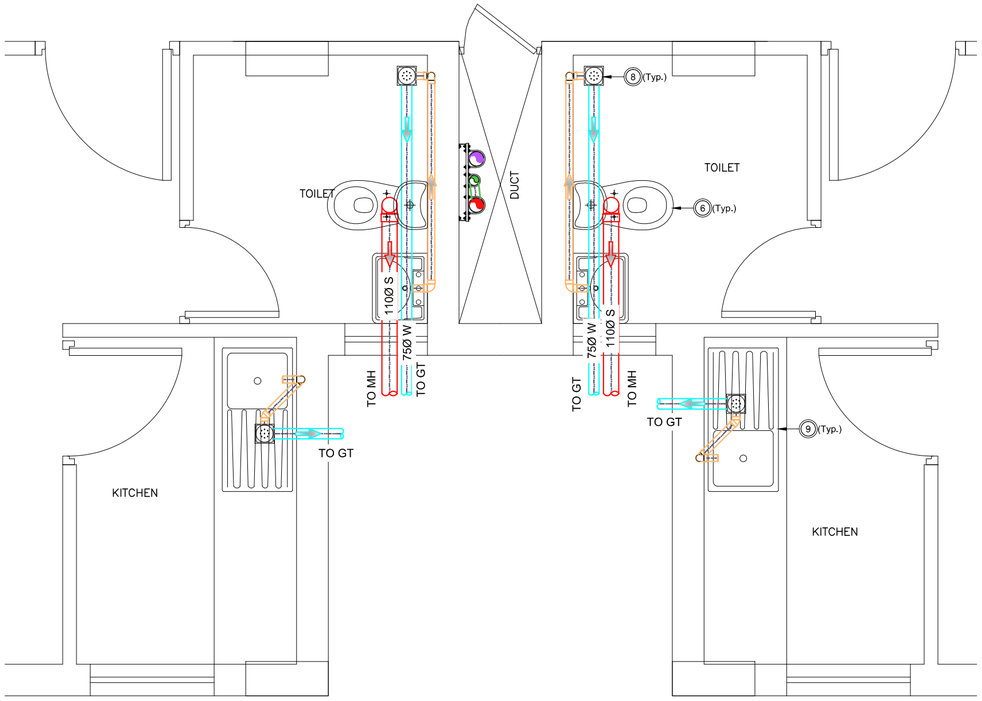
REV.
P0

SCALE
NTS

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SANITARY LAYOUT (DETAIL A)

LEGEND:

	50Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	75Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (HEADER)
	110Ø WASTE PIPE (HEADER)
	75Ø VENT PIPE (HEADER)PVC 4Kg/cm²
S	SOIL PIPE
W	WASTE PIPE
GT	GULLY TRAP
MH	MANHOLE

NOTATION	ITEM
6	FLOOR MOUNTED WATER CLOSET
7	WALL HUNG WASH BASIN
8	FLOOR TRAP 110 mm OUTER DIA (MULTI TRAP) INCLUDING CP COCKROACH FREE FLOOR GRATING WITH CUP
9	SS SINK

NOTE :-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED
3. PROVIDE DOOR FACILITIES FOR ACCESS AT ALL JUNCTIONS AND TURNINGS.
4. A MINIMUM DISTANCE OF 150mm SHOULD BE KEPT BETWEEN WALL & FLOOR TRAP CENTRE.
5. ALL PIPES SHOWN ARE **PVC6 kg/cm²** EXCEPT FOR VENT PIPES
6. ALL VENT PIPE SHOWN ARE PVC 4kg/cm².
7. THE DIAMETER OF PIPE LINES GIVEN IN THE DRAWINGS ARE OUTSIDE DIMENSIONS FOR PVC PIPES.
8. THE SEWER PIPE LINES SHALL BE TESTED BY COMPLETELY FILLING THE SEWER PIPE WITH WATER BY PLUGGING LOWEST POINT TO THE HIGHEST POINT OF THE SEWER PIPE LINE SECTION. THE SEWER PIPE SHALL BE WATER TIGHT AT ALL POINTS.
9. ALL ITEMS/SHADES SHALL BE GOT APPROVED FROM DESIGN OFFICE AND ENGINEER-IN-CHARGE PRIOR TO BULK PROCUREMENT.
10. PIPES SUPPORT SPACING FOR VERTICAL RISERS UP TO 40mm DIA IS 2m AND 3m FOR 40mm DIA AND ABOVE.
11. NO PIPES SHALL BE SEEN EXPOSED.

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL SMART THINGS

OFFICE OF ORIGIN
RANCHI
FLAT NO-5A 6th FLOOR MARU TOWER
RANIK ROAD HATWA
RANCHI-834006,JHARKHAND.
TEL:0651-2247861

CLIENT: GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE: 06-JUN-2019

ENGINEERING CONSULTANT: DARASHAW & CO.PVT.LTD
HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN: S.AHMAD

PROJECT: PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED: KALLOL DAS

TITLE: LAYOUT OF INTERNAL SANITARY LINES GROUND FLOOR- BLOCK (EWS TYPE-1)

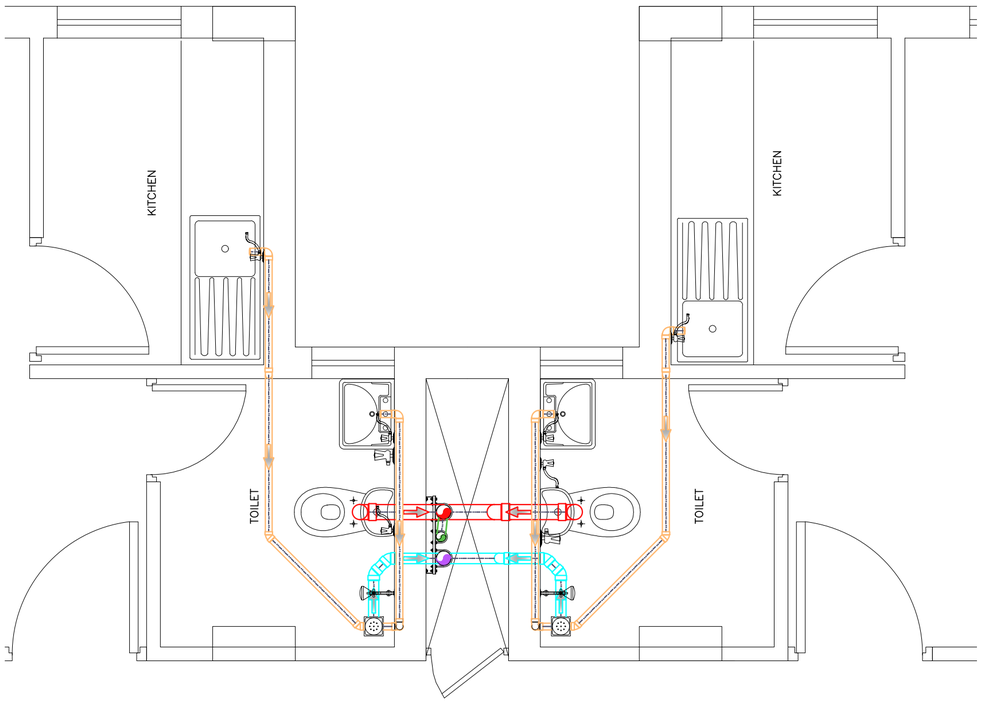
APPROVED: GEORGE THAMBI

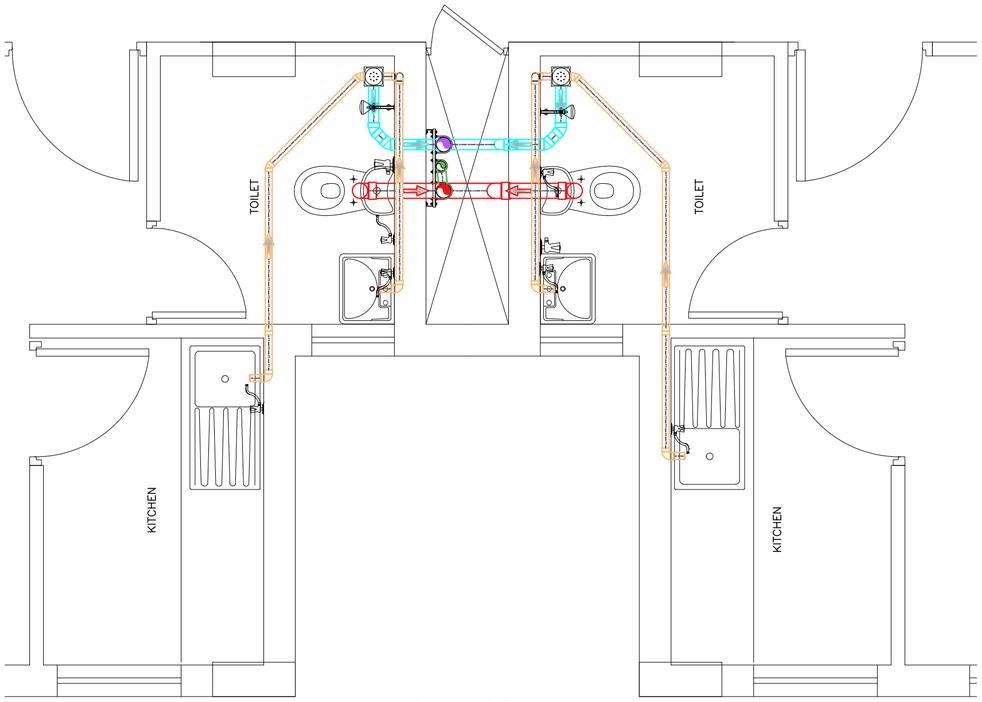
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REV. P0

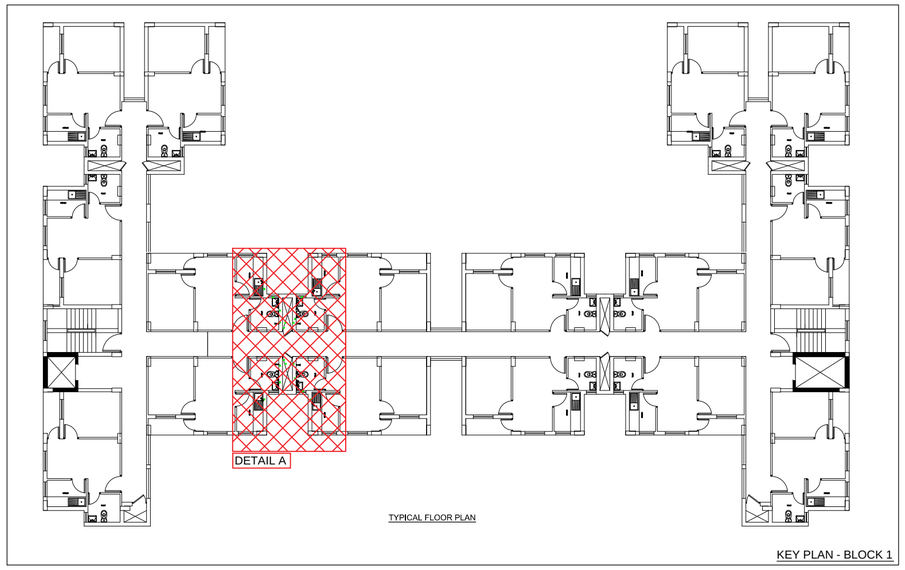
SCALE 1:100

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SANITARY LAYOUT (DETAIL A)



KEY PLAN - BLOCK 1

LEGEND:

	50Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	75Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (HEADER)
	110Ø WASTE PIPE (HEADER)
	75Ø VENT PIPE (HEADER)PVC 4Kg/cm²
S	SOIL PIPE
W	WASTE PIPE

NOTATION	ITEM
6	FLOOR MOUNTED WATER CLOSET
7	WALL HUNG WASH BASIN
8	FLOOR TRAP 110 mm OUTER DIA (MULTI TRAP) INCLUDING CP COCKROACH FREE FLOOR GRATING WITH CUP
9	SS SINK

NOTE :-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED
3. PROVIDE DOOR FACILITIES FOR ACCESS AT ALL JUNCTIONS AND TURNINGS.
4. A MINIMUM DISTANCE OF 150mm SHOULD BE KEPT BETWEEN WALL & FLOOR TRAP CENTRE.
5. ALL PIPES SHOWN ARE **PVC6 kg/cm²** EXCEPT FOR VENT PIPES
6. ALL VENT PIPE SHOWN ARE PVC 4kg/cm².
7. THE DIAMETER OF PIPE LINES GIVEN IN THE DRAWINGS ARE OUTSIDE DIMENSIONS FOR PVC PIPES.
8. THE SEWER PIPE LINES SHALL BE TESTED BY COMPLETELY FILLING THE SEWER PIPE WITH WATER BY PLUGGING LOWEST POINT TO THE HIGHEST POINT OF THE SEWER PIPE LINE SECTION. THE SEWER PIPE SHALL BE WATER TIGHT AT ALL POINTS.
9. ALL ITEMS/SHADES SHALL BE GOT APPROVED FROM DESIGN OFFICE AND ENGINEER-IN-CHARGE PRIOR TO BULK PROCUREMENT.
10. PIPES SUPPORT SPACING FOR VERTICAL RISERS UP TO 40mm DIA IS 2m AND 3m FOR 40mm DIA AND ABOVE.
11. NO PIPES SHALL BE SEEN EXPOSED.

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL SMART THINGS

OFFICE OF ORIGIN
RANCHI
FLAT NO-5A 6th FLOOR MARU TOWER
RANIE ROAD HATMA
RANCHI-834008,JHARKHAND.
TEL:0651-2247861.

CLIENT: GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE: 06-JUN-2019

ENGINEERING CONSULTANT: DARASHAW & CO.PVT.LTD
HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN: S.AHMAD

PROJECT: PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED: KALLOL DAS

TITLE: LAYOUT OF INTERNAL SANITARY LINES TYPICAL FLOOR- BLOCK (EWS TYPE-1)

APPROVED: GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/SR/WD/17

REV. P0

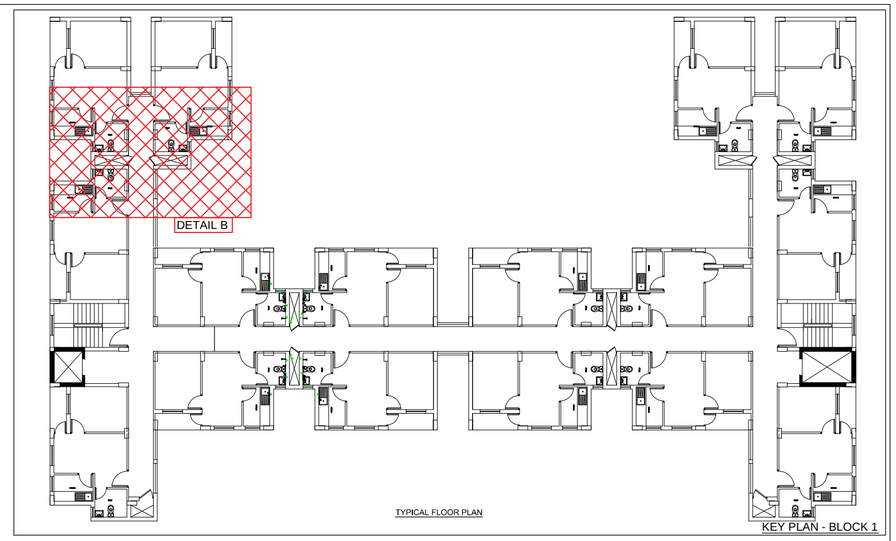
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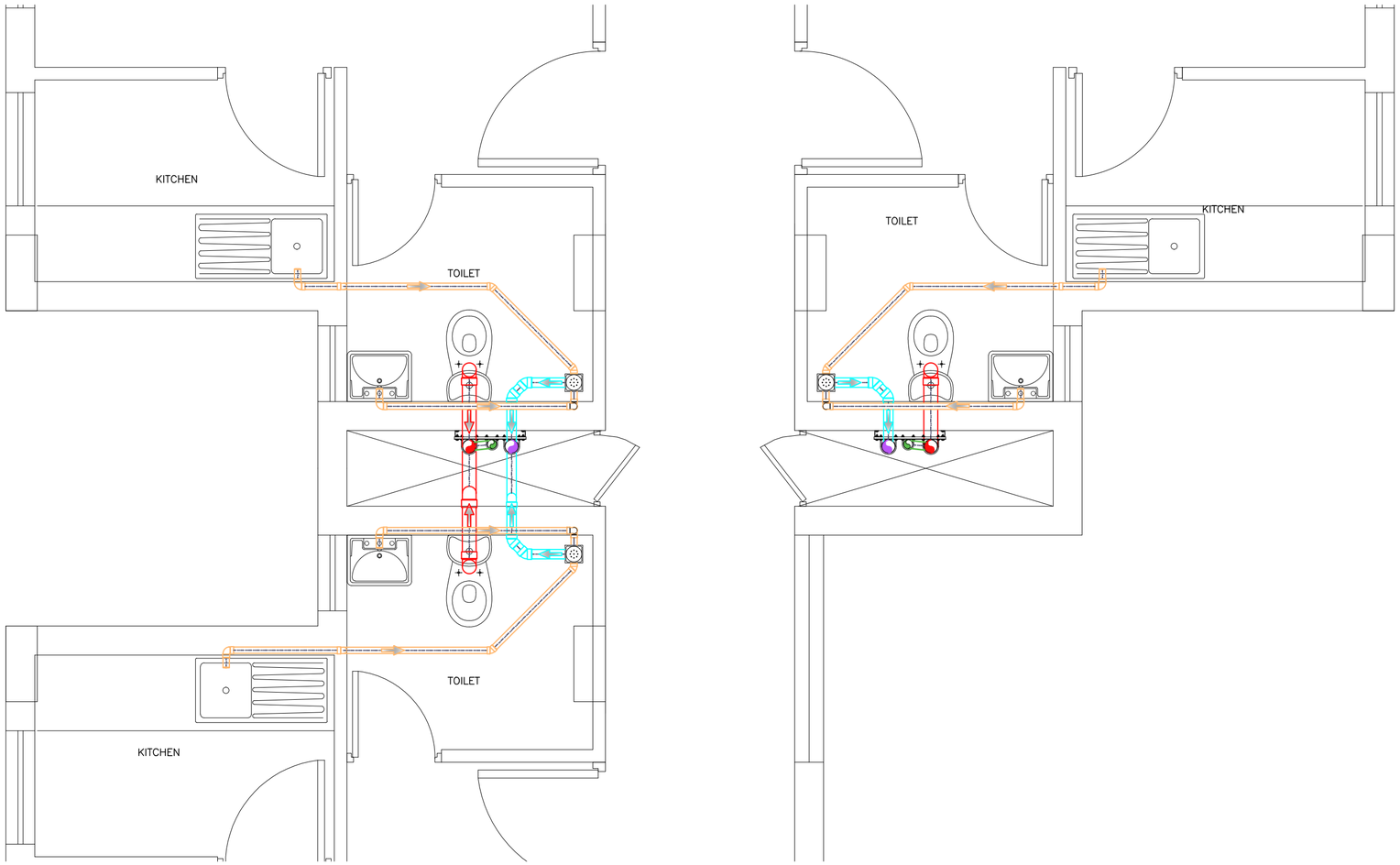
NOTATION	ITEM
6	FLOOR MOUNTED WATER CLOSET
7	WALL HUNG WASH BASIN
8	FLOOR TRAP 110 mm OUTER DIA (MULTI TRAP) INCLUDING CP COCKROACH FREE FLOOR GRATING WITH CUP
9	SS SINK

LEGEND:

	50Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	75Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (HEADER)
	110Ø WASTE PIPE (HEADER)
	75Ø VENT PIPE (HEADER)PVC 4Kg/cm²
S	SOIL PIPE
W	WASTE PIPE



KEY PLAN - BLOCK 1



SANITARY LAYOUT (DETAIL B)

NOTE :-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED
3. PROVIDE DOOR FACILITIES FOR ACCESS AT ALL JUNCTIONS AND TURNINGS.
4. A MINIMUM DISTANCE OF 150mm SHOULD BE KEPT BETWEEN WALL & FLOOR TRAP CENTRE.
5. ALL PIPES SHOWN ARE **PVC6 kg/cm²** EXCEPT FOR VENT PIPES
6. ALL VENT PIPE SHOWN ARE PVC 4kg/cm².
7. THE DIAMETER OF PIPE LINES GIVEN IN THE DRAWINGS ARE OUTSIDE DIMENSIONS FOR PVC PIPES.
8. THE SEWER PIPE LINES SHALL BE TESTED BY COMPLETELY FILLING THE SEWER PIPE WITH WATER BY PLUGGING LOWEST POINT TO THE HIGHEST POINT OF THE SEWER PIPE LINE SECTION. THE SEWER PIPE SHALL BE WATER TIGHT AT ALL POINTS.
9. ALL ITEMS/SHADES SHALL BE GOT APPROVED FROM DESIGN OFFICE AND ENGINEER-IN-CHARGE PRIOR TO BULK PROCUREMENT.
10. PIPES SUPPORT SPACING FOR VERTICAL RISERS UP TO 40mm DIA IS 2m AND 3m FOR 40mm DIA AND ABOVE.
11. NO PIPES SHALL BE SEEN EXPOSED.

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW & CO. A JLT GROUP FIRM

OFFICE OF ORIGIN
RANCHI
FLAT NO.GA 6th FLOOR MARU TOWER KANKE ROAD HATMA RANCHI-834008,JHARKHAND. TEL:0651-2247981

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD
HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
LAYOUT OF INTERNAL SANITARY LINES
TYPICAL FLOOR- BLOCK (EWS TYPE-1)

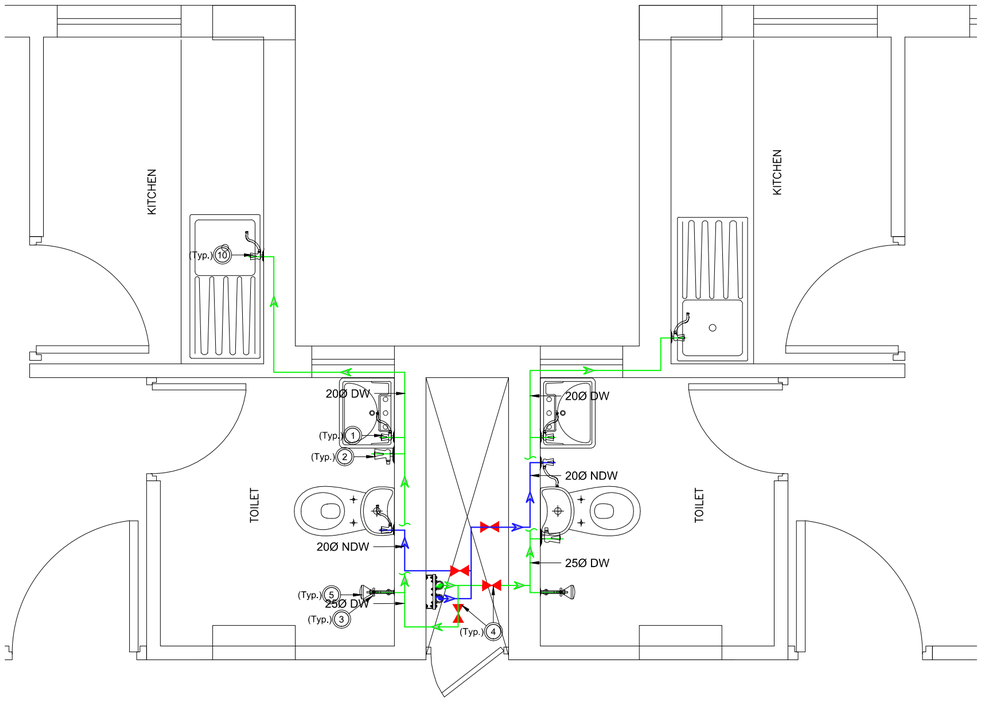
APPROVED
GEORGE THAMBI

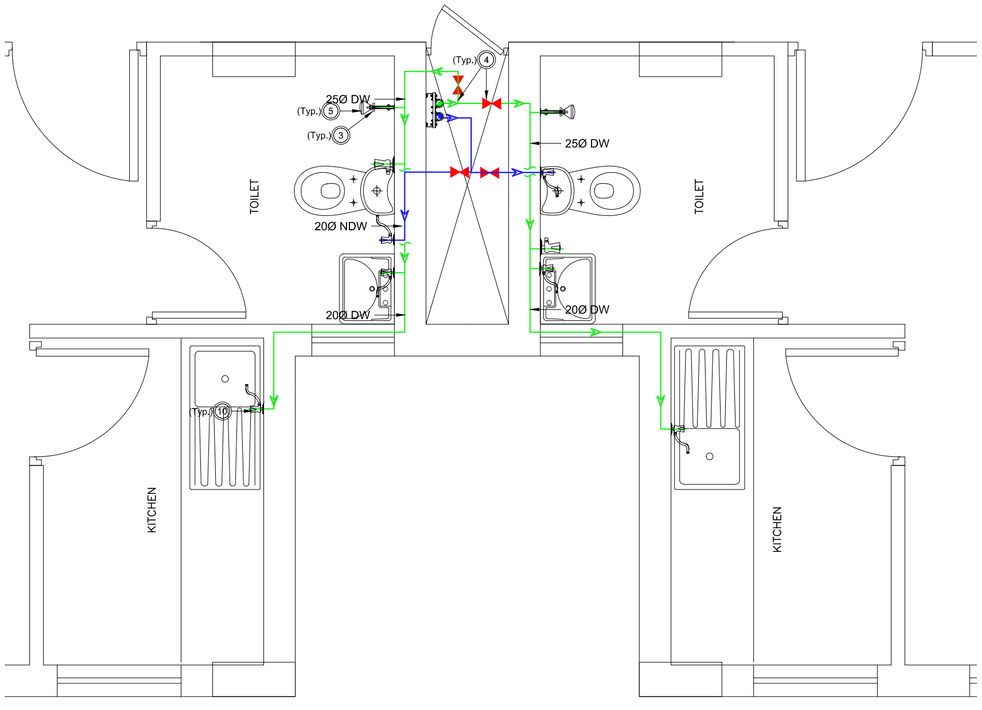
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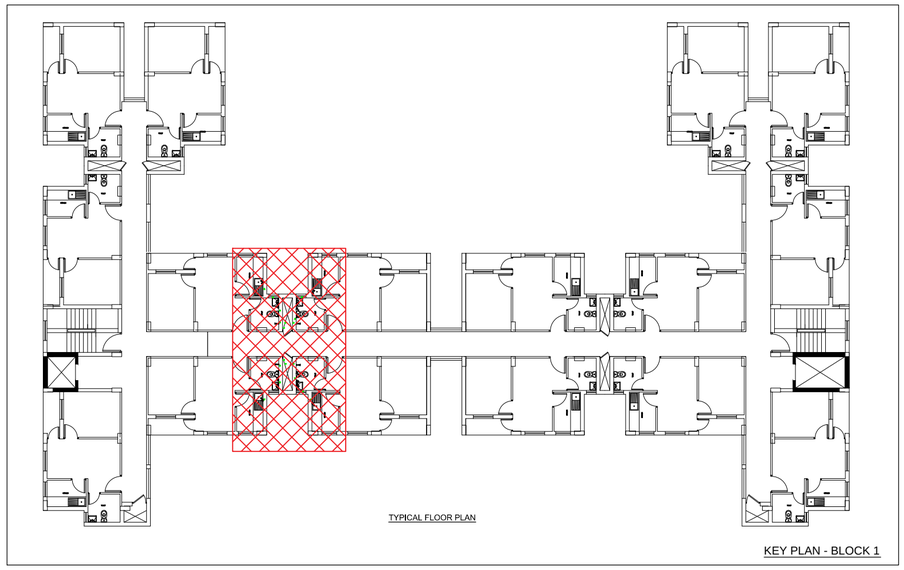
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SCALE
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KEY PLAN - BLOCK 1

LEGEND

- DRINKING WATER [DW] PIPE (CONCEALED) CPVC SDR 11 (NOMINAL DIA)
- NON DRINKING WATER [NDW] PIPE (CONCEALED) CPVC SDR 11(NOMINAL DIA)
- DRINKING WATER (DW) HEADER CPVC SDR11 (NOMINAL DIA)
- NON DRINKING WATER (NDW) HEADER CPVC SDR11 (NOMINAL DIA)
- GM GATE VALVE

NOTATION	ITEM
1	PILLAR COCK + ANGLE VALVE
2	ANGLE VALVE + HEALTH FAUCET @ 450AFFL
3	LONG BODY BIBCOCK
4	ISOLATION VALVE
5	CP BRASS SHOWER @ 2050AFFL
10	SINK MIXER

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED.
3. **ALL CONCEALED LINES ARE CPVC SDR11.**
4. THE DIAMETER OF PIPE LINES GIVEN IN THE DRAWINGS ARE NOMINAL DIMENSION FOR CPVC PIPES.
5. AFTER LAYING & JOINTING, THE PIPE LINES SHALL BE PRESSURE TESTED TO WITHSTAND 2 BAR HYDROSTATIC TEST PRESSURE AS PER MANUAL ON W.S. AND TREATMENT 3RD EDITION.
6. NO PIPES SHALL BE EXPOSED.
7. PIPE-LINE SHOULD BE SECURELY ANCHORED AT DEAD ENDS, TEES, BENDS, TAPERS AND VALVES TO RESIST THRUST ARISING FROM INTERNAL PRESSURE.ANCHORS AND THRUST BLOCKS SHOULD BE DESIGNED IN ACCORDANCE WITH IS 5330 : 1984.

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ELP EXPORT FIRST

JUIDCO

OFFICE OF ORIGIN
RANCHI
FLAT NO.04 6th FLOOR MARU TOWER KANKE ROAD HATMA RANCHI-834008,JHARKHAND. TEL:0651-2547865.

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS, NARIMAN POINT, MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
LAYOUT OF INTERNAL WATER SUPPLY LINES GF TO 8TH FLOORS - EWS TYPE 1

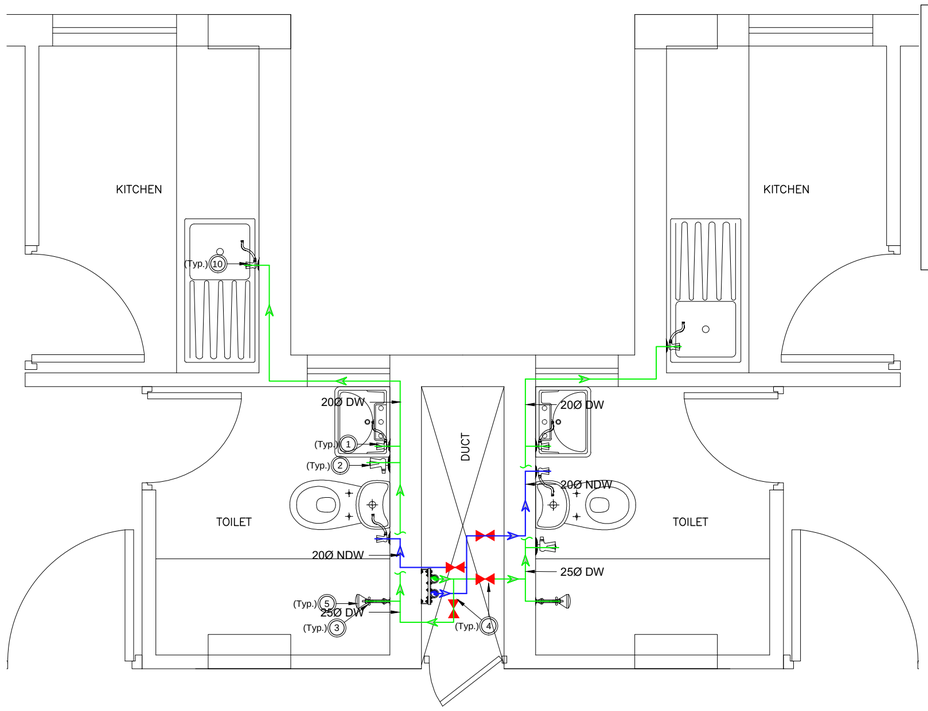
APPROVED
GEORGE THAMBI

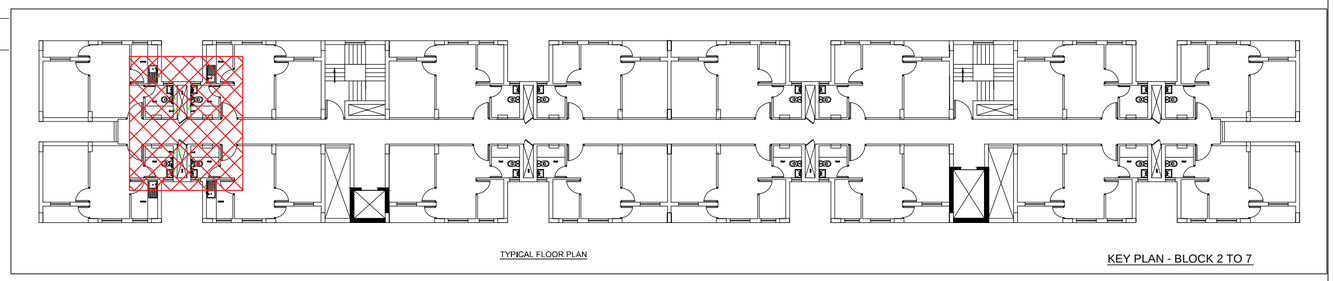
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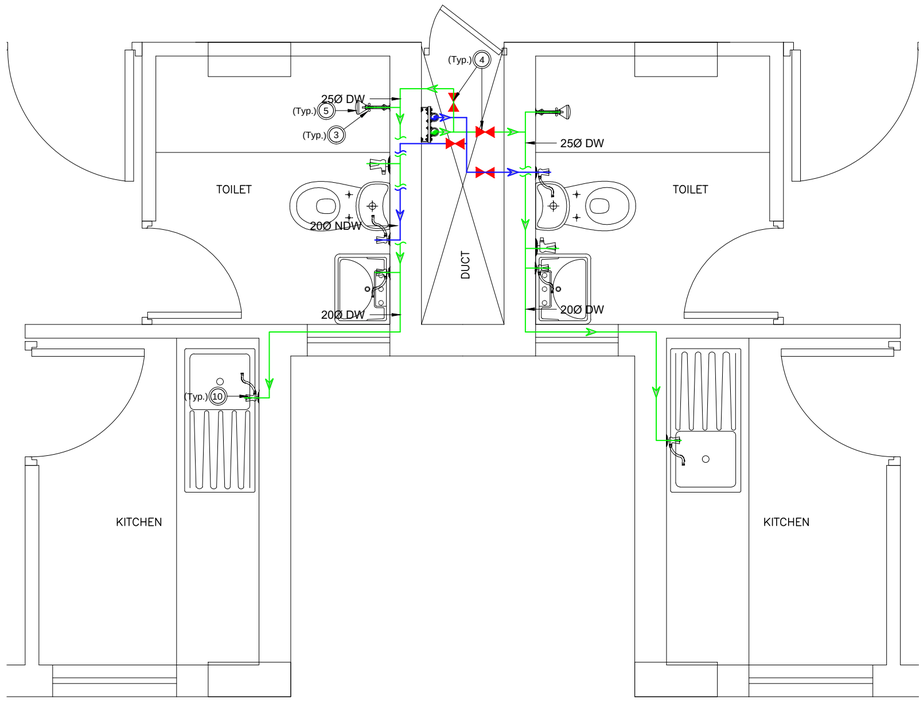
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SCALE
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LEGEND

- DRINKING WATER [DW] PIPE (CONCEALED) CPVC SDR 11 (NOMINAL DIA)
- NON DRINKING WATER [NDW] PIPE (CONCEALED) CPVC SDR 11(NOMINAL DIA)
- DRINKING WATER (DW) HEADER CPVC SDR11 (NOMINAL DIA)
- NON DRINKING WATER (NDW) HEADER CPVC SDR11 (NOMINAL DIA)
- GM GATE VALVE

NOTATION	ITEM
1	PILLAR COCK + ANGLE VALVE
2	ANGLE VALVE + HEALTH FAUCET @ 450AFFL
3	LONG BODY BIBCOCK
4	ISOLATION VALVE
5	CP BRASS SHOWER @ 2050AFFL
10	SINK MIXER

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED.
3. **ALL CONCEALED LINES ARE CPVC SDR11.**
4. THE DIAMETER OF PIPE LINES GIVEN IN THE DRAWINGS ARE NOMINAL DIMENSION FOR CPVC PIPES.
5. AFTER LAYING & JOINTING, THE PIPE LINES SHALL BE PRESSURE TESTED TO WITHSTAND 2 BAR HYDROSTATIC TEST PRESSURE AS PER MANUAL ON W.S. AND TREATMENT 3RD EDITION.
6. NO PIPES SHALL BE EXPOSED.
7. PIPE-LINE SHOULD BE SECURELY ANCHORED AT DEAD ENDS, TEES, BENDS, TAPERS AND VALVES TO RESIST THRUST ARISING FROM INTERNAL PRESSURE.ANCHORS AND THRUST BLOCKS SHOULD BE DESIGNED IN ACCORDANCE WITH IS 5330 : 1984.

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL ROADS THERE

OFFICE OF ORIGIN
RANCHI
FLAT NO-5A 6th FLOOR MARU TOWER
RANIE ROAD HATWA
RANCHI-834006,JHARKHAND.
TEL:0651-2247861

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD
HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
LAYOUT OF INTERNAL WATER SUPPLY LINES
TYPICAL FLOOR- BLOCK (EWS TYPE-2)

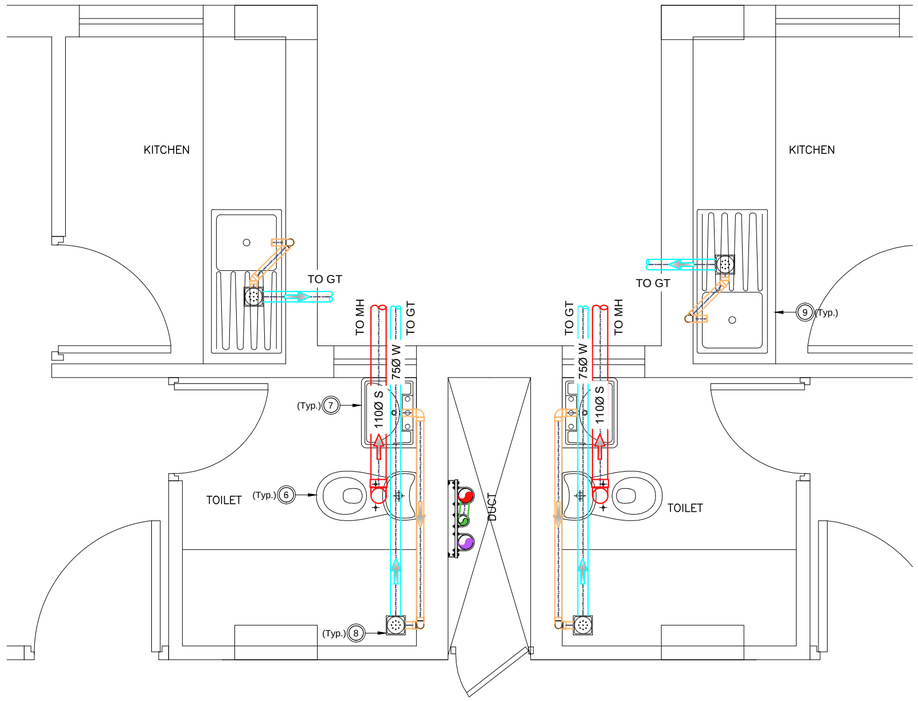
APPROVED
GEORGE THAMBI

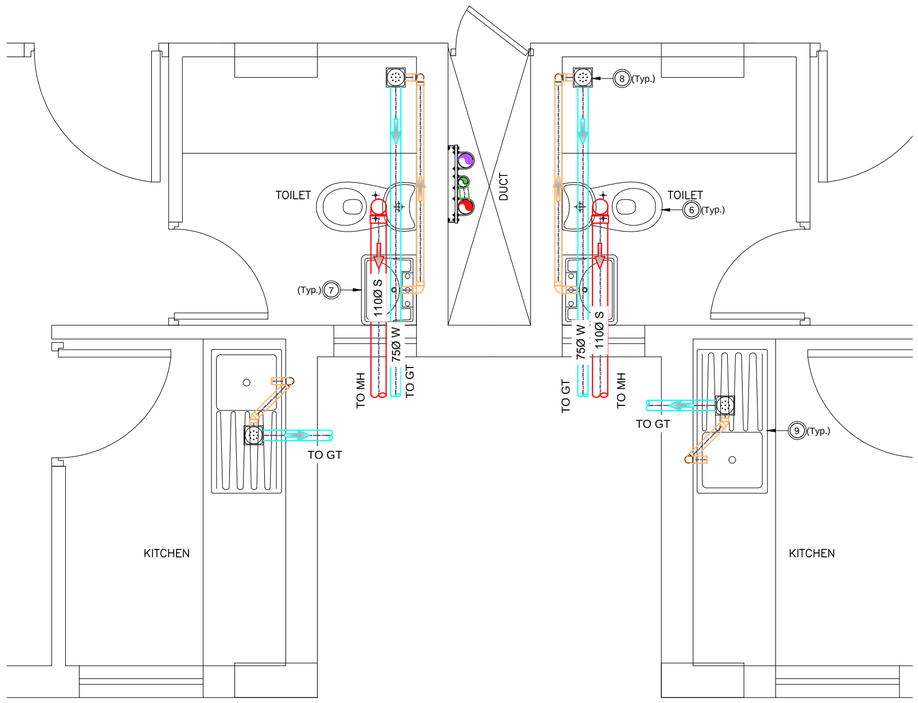
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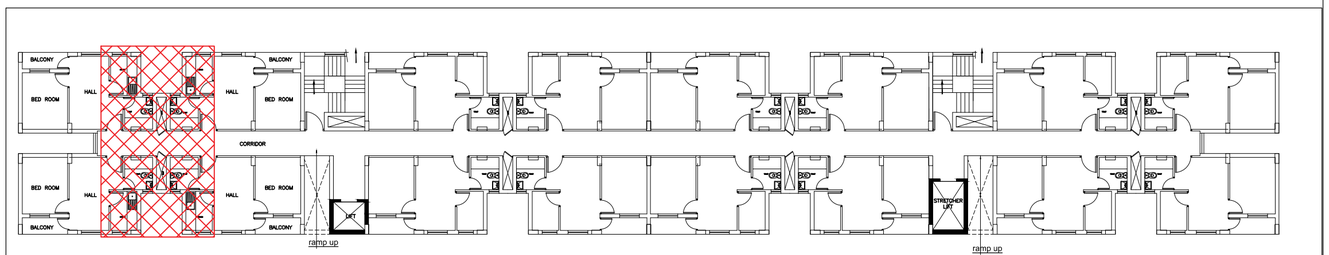
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KEY PLAN - GROUND FLOOR - BLOCK 2 TO 7

LEGEND:

	50Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	75Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (HEADER)
	110Ø WASTE PIPE (HEADER)
	75Ø VENT PIPE (HEADER)PVC 4Kg/cm²
S	SOIL PIPE
W	WASTE PIPE
GT	GULLY TRAP
MH	MANHOLE

NOTATION	ITEM
6	FLOOR MOUNTED WATER CLOSET
7	WALL HUNG WASH BASIN
8	FLOOR TRAP 110 mm OUTER DIA (MULTI TRAP) INCLUDING CP COCKROACH FREE FLOOR GRATING WITH CUP
9	SS SINK

NOTE :-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED
3. PROVIDE DOOR FACILITIES FOR ACCESS AT ALL JUNCTIONS AND TURNINGS.
4. A MINIMUM DISTANCE OF 150mm SHOULD BE KEPT BETWEEN WALL & FLOOR TRAP CENTRE.
5. ALL PIPES SHOWN ARE **PVC6 kg/cm²** EXCEPT FOR VENT PIPES
6. ALL VENT PIPE SHOWN ARE PVC 4kg/cm².
7. THE DIAMETER OF PIPE LINES GIVEN IN THE DRAWINGS ARE OUTSIDE DIMENSIONS FOR PVC PIPES.
8. THE SEWER PIPE LINES SHALL BE TESTED BY COMPLETELY FILLING THE SEWER PIPE WITH WATER BY PLUGGING LOWEST POINT TO THE HIGHEST POINT OF THE SEWER PIPE LINE SECTION. THE SEWER PIPE SHALL BE WATER TIGHT AT ALL POINTS.
9. ALL ITEMS/SHADES SHALL BE GOT APPROVED FROM DESIGN OFFICE AND ENGINEER-IN-CHARGE PRIOR TO BULK PROCUREMENT.
10. PIPES SUPPORT SPACING FOR VERTICAL RISERS UP TO 40mm DIA IS 2m AND 3m FOR 40mm DIA AND ABOVE.
11. NO PIPES SHALL BE SEEN EXPOSED.

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL SMART THINGS

OFFICE OF ORIGIN
RANCHI
FLAT NO-5A 6th FLOOR MARU TOWER
RANE ROAD HATIA
RANCHI-834006,JHARKHAND.
TEL:0651-2242981

CLIENT: GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE: 06-JUN-2019

ENGINEERING CONSULTANT: DARASHAW & CO.PVT.LTD
HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN: S.AHMAD

PROJECT: PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED: KALLOL DAS

TITLE: LAYOUT OF INTERNAL SANITARY LINES GROUND FLOOR - (TYPE-2)

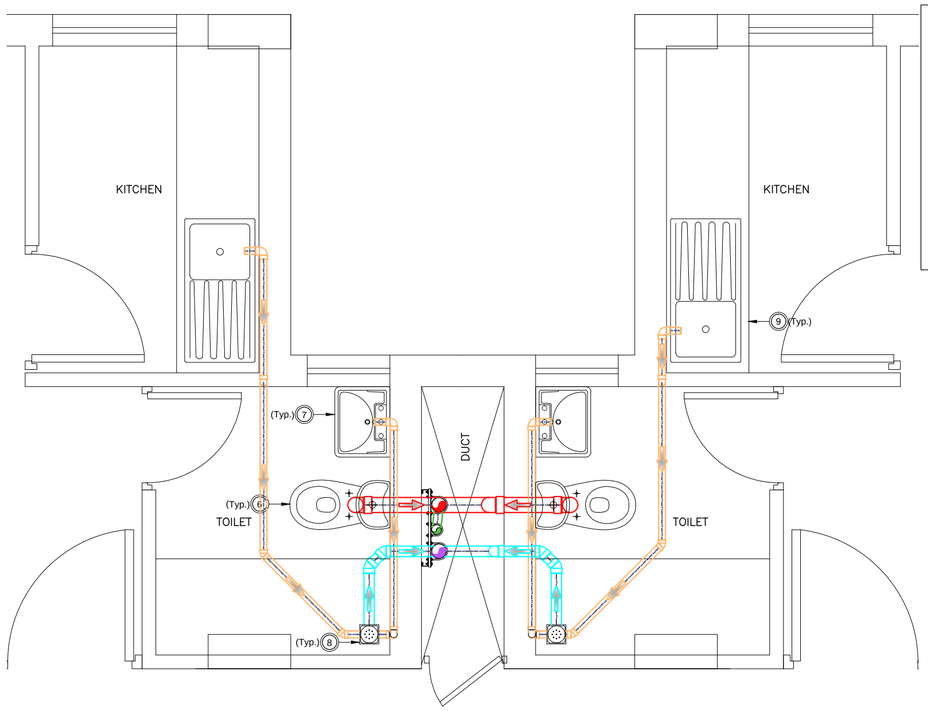
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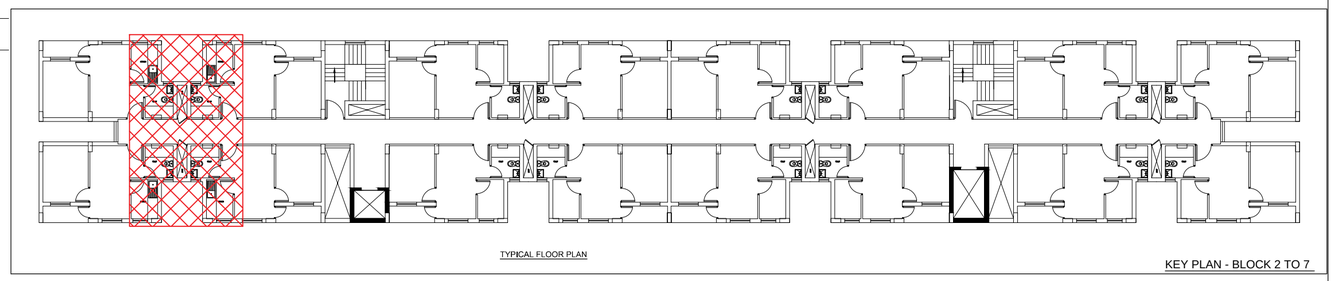
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REV. P0

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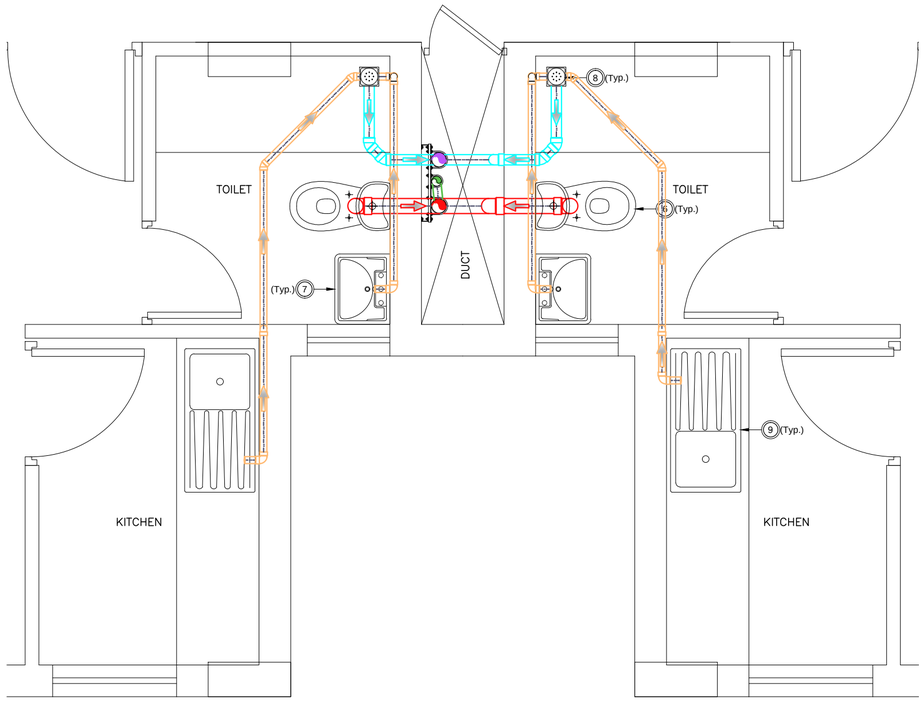
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TYPICAL FLOOR PLAN

KEY PLAN - BLOCK 2 TO 7



LEGEND:

	50Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	75Ø WASTE WATER PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (CONCEALED) PVC 6Kg/cm²
	110Ø SOIL PIPE (HEADER)
	110Ø WASTE PIPE (HEADER)
	75Ø VENT PIPE (HEADER)PVC 4Kg/cm²
S	SOIL PIPE
W	WASTE PIPE

NOTATION	ITEM
6	FLOOR MOUNTED WATER CLOSET
7	WALL HUNG WASH BASIN
8	FLOOR TRAP 110 mm OUTER DIA (MULTI TRAP) INCLUDING CP COCKROACH FREE FLOOR GRATING WITH CUP
9	SS SINK

NOTE :-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED
3. PROVIDE DOOR FACILITIES FOR ACCESS AT ALL JUNCTIONS AND TURNINGS.
4. A MINIMUM DISTANCE OF 150mm SHOULD BE KEPT BETWEEN WALL & FLOOR TRAP CENTRE.
5. ALL PIPES SHOWN ARE **PVC6 kg/cm²** EXCEPT FOR VENT PIPES
6. ALL VENT PIPE SHOWN ARE PVC 4kg/cm².
7. THE DIAMETER OF PIPE LINES GIVEN IN THE DRAWINGS ARE OUTSIDE DIMENSIONS FOR PVC PIPES.
8. THE SEWER PIPE LINES SHALL BE TESTED BY COMPLETELY FILLING THE SEWER PIPE WITH WATER BY PLUGGING LOWEST POINT TO THE HIGHEST POINT OF THE SEWER PIPE LINE SECTION. THE SEWER PIPE SHALL BE WATER TIGHT AT ALL POINTS.
9. ALL ITEMS/SHADES SHALL BE GOT APPROVED FROM DESIGN OFFICE AND ENGINEER-IN-CHARGE PRIOR TO BULK PROCUREMENT.
10. PIPES SUPPORT SPACING FOR VERTICAL RISERS UP TO 40mm DIA IS 2m AND 3m FOR 40mm DIA AND ABOVE.
11. NO PIPES SHALL BE SEEN EXPOSED.

NOTES :-

1. ALL DIMENSIONS ARE IN METER AND LEVELS IN METER.
2. THE LAYOUT HAS BEEN PREPARED IN ACCORDANCE WITH APPLICABLE PROVISIONS OF JHARKHAND BUILDING BYE LAWS - 2016 (FOR AFFORDABLE HOUSING).

DATE	NO.	REVISION	DRAWN	CHECKED	APPROVED

DARASHAW 1925 ALL SMART THINGS

JUIDCO

OFFICE OF ORIGIN
RANCHI
FLAT NO-5A 6th FLOOR MARU TOWER
RANE ROAD HATWA
RANCHI-834006,JHARKHAND.
TEL:0651-2247861.

CLIENT: GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE: 06-JUN-2019

ENGINEERING CONSULTANT: DARASHAW & CO.PVT.LTD
HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN: S.AHMAD

PROJECT: PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED: KALLOL DAS

TITLE: LAYOUT OF INTERNAL SANITARY LINES TYPICAL FLOORS - (TYPE-2)

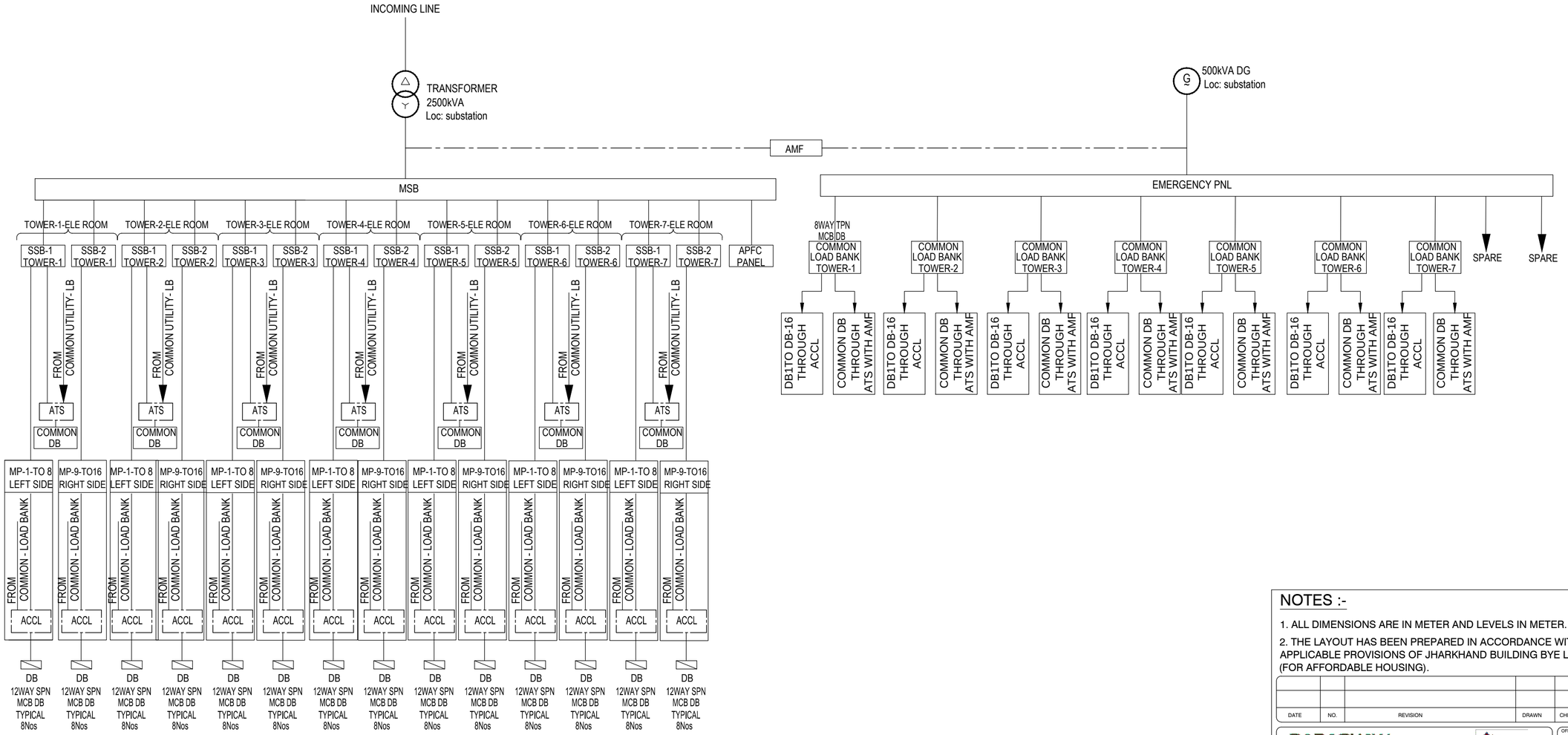
APPROVED: GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/SR/WD/22

REV. P0

SCALE 1:100

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KANKE ROAD HATMA
RANCHI-834008,JHARKHAND.
TEL.0651-2547888.

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
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MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION,
DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
POWER DISTRIBUTION BLOCK DIAGRAM

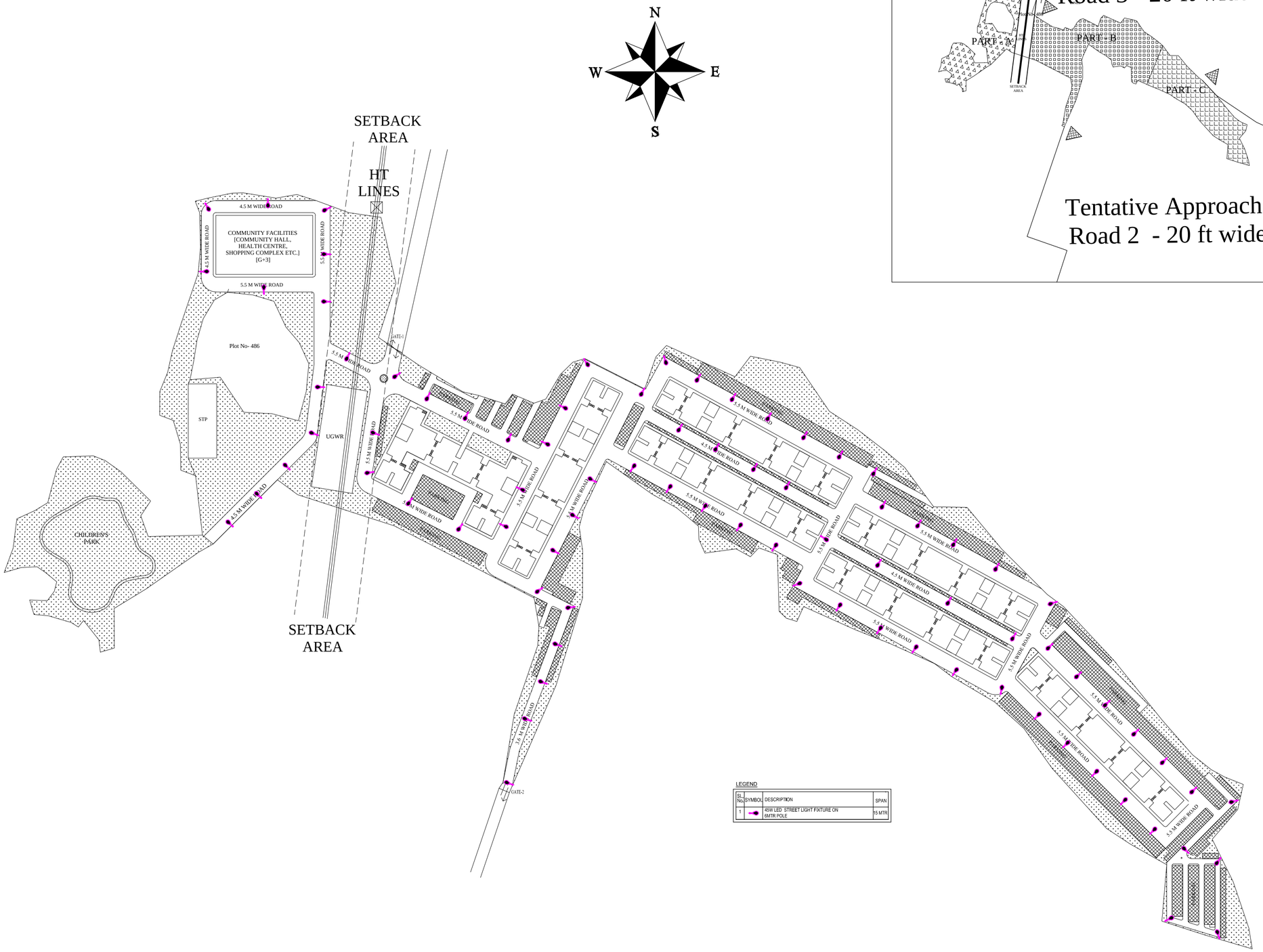
APPROVED
GEORGE THAMBI

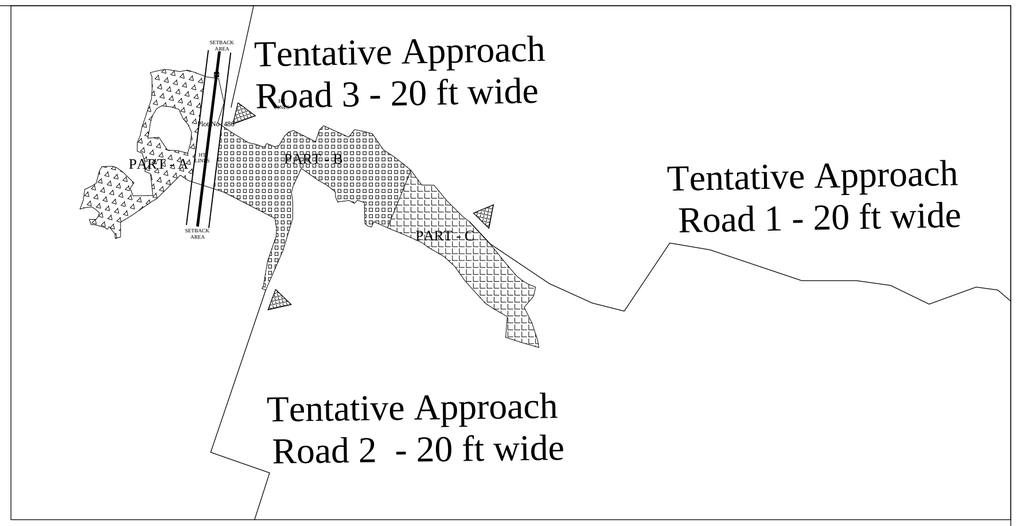
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LEGEND

SL. No.	SYMBOL	DESCRIPTION	SPAN
1		45W LED STREET LIGHT FIXTURE ON 6MTR POLE	15 MTR

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12th FLOOR, REGENT CHAMBERS, NARIMAN POINT, MUMBAI - 400021

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PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
EXTERNAL LIGHTING LAYOUT

APPROVED
GEORGE THAMBI

DRG. NO. DCPL/0460T/LHP/SR/WD/24

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LEGEND:-

- HNS DRINKING WATER [DW] PIPE
- NON DRINKING WATER [NDW] PIPE
- GM GATE VALVE / SLUICE VALVE
- NON RETURN VALVE (NRV)
- MOTORIZED VALVE (MV)
- BASKET TYPE STRAINER
- Y STRAINER
- ONLINE WATER METER
- NO NORMALLY OPEN
- HNS HYDRO PNEUMATIC SYSTEM

NOTES :-

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DATE
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NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
WATER SUPPLY FLOW DIAGRAM

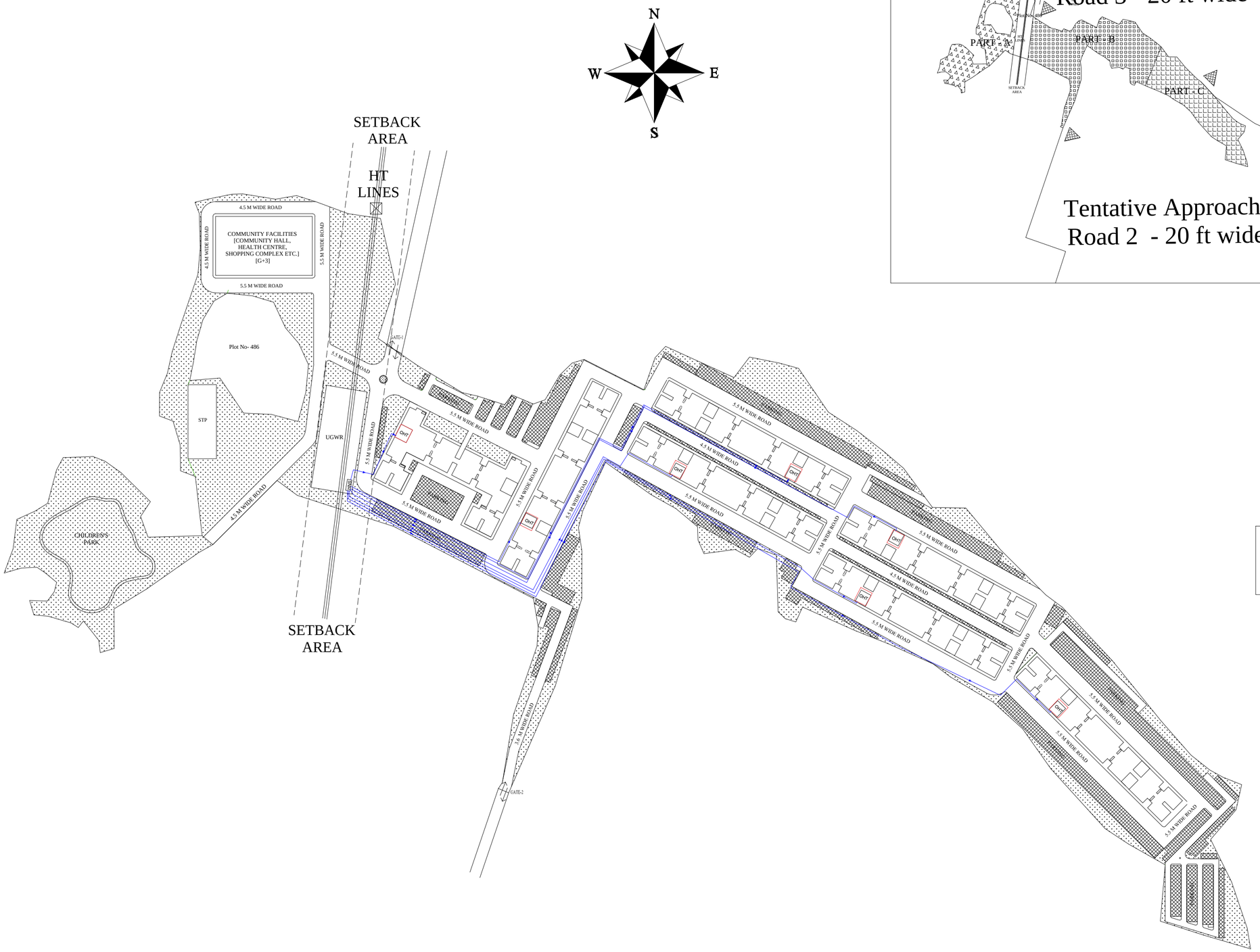
APPROVED
GEORGE THAMBI

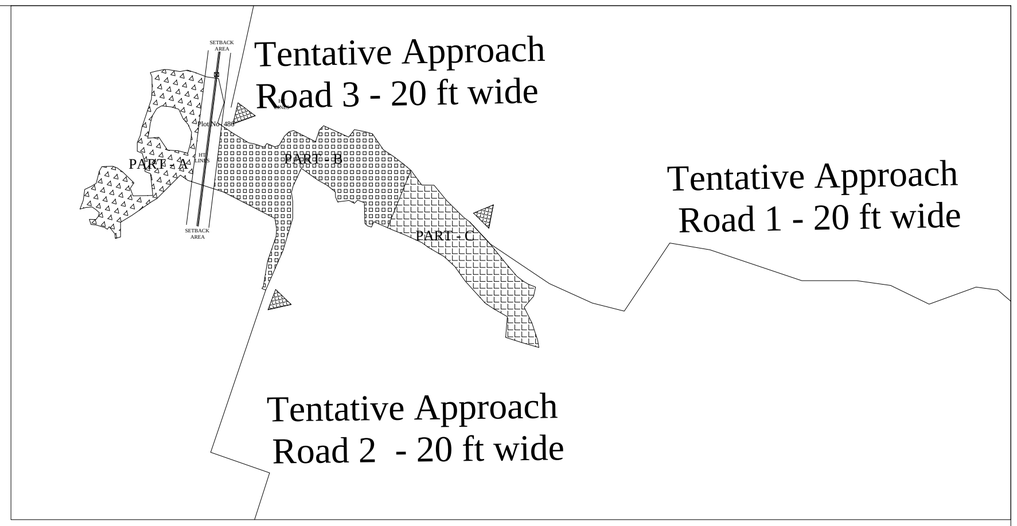
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LEGENDS :-

DOMESTIC WATER SUPPLY PIPE

NOTES :-

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JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

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06-JUN-2019

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DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS, NARIMAN POINT, MUMBAI - 400021

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S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
EXTERNAL WATER SUPPLY LAYOUT

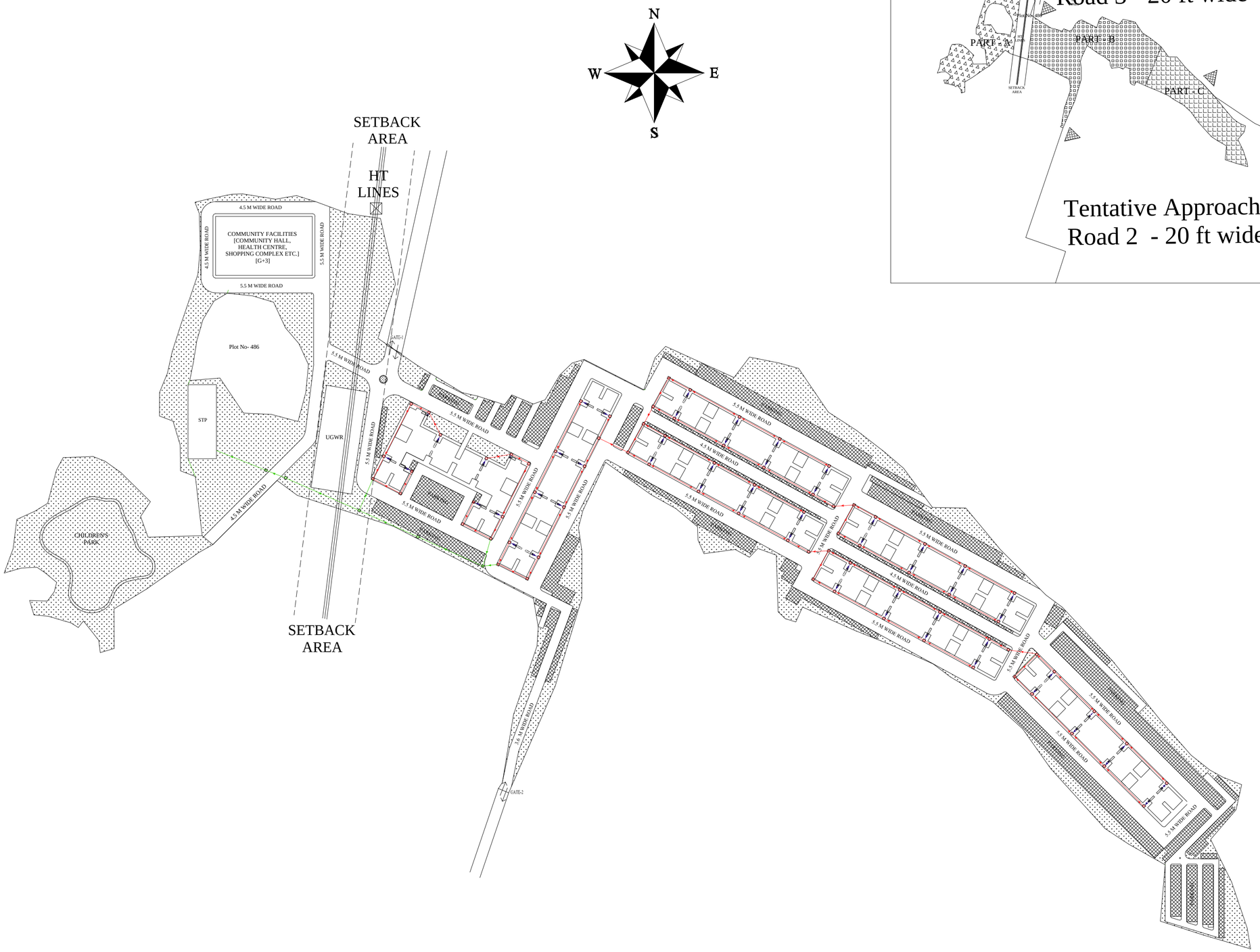
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GEORGE THAMBI

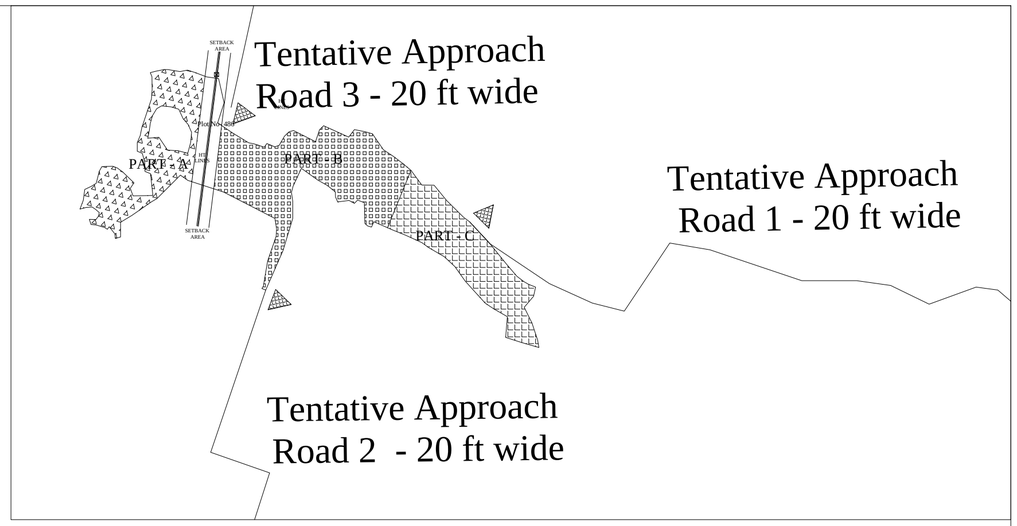
DRG. NO. DCPL/0460T/LHP/SR/WD/27

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LEGENDS :-

- 110Ø WASTE WATER PIPE
- 160Ø SOIL PIPE
- 200Ø SOIL PIPE
- GULLY TRAP
- MANHOLE

NOTES :-

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DATE
06-JUN-2019

ENGINEERING CONSULTANT:
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HEAD OFFICE
12th FLOOR, REGENT CHAMBERS, NARIMAN POINT, MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
EXTERNAL SEWER LAYOUT

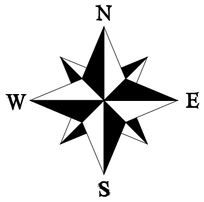
APPROVED
GEORGE THAMBI

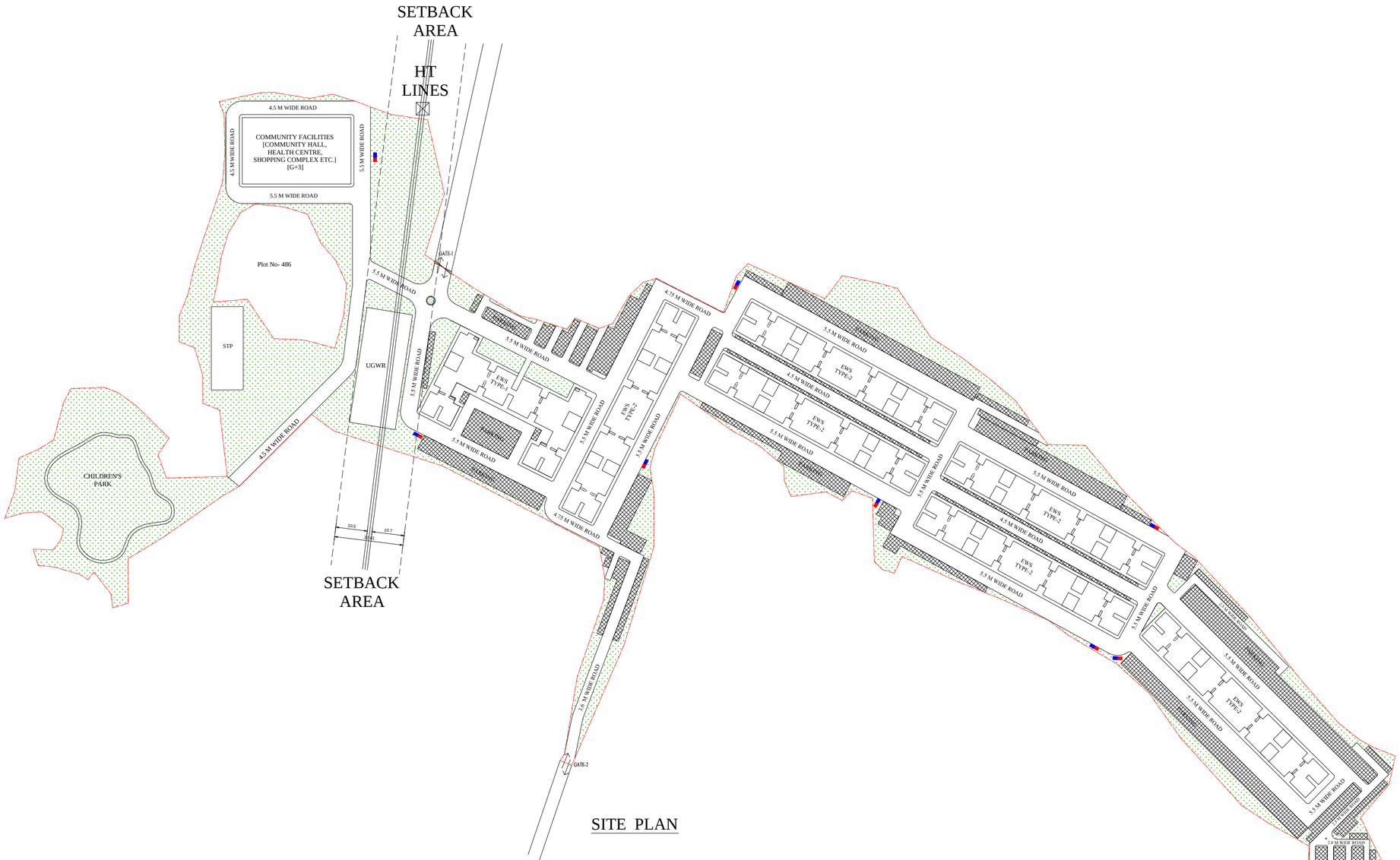
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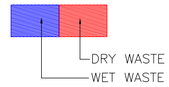
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LEGEND:

---------- DUSTBIN

---------- PARKING AREA

---------- GREEN AREA

NOTES :-

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4TH FLOOR,4th FLOOR MARU TOWER
KANKE ROAD,HATMA
RANCHI-834008,JHARKHAND.
TEL:0651-2547866

CLIENT:
GOVERNMENT OF JHARKHAND
JHARKHAND URBAN INFRASTRUCTURE DEVELOPMENT CORPORATION LTD

DATE
06-JUN-2019

ENGINEERING CONSULTANT:
DARASHAW & CO.PVT.LTD

HEAD OFFICE
12th FLOOR, REGENT CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021

DRAWN
S.AHMAD

PROJECT:
PREPARATION OF HOUSING FOR ALL PLAN OF ACTION, DPR AND PMC UNDER PMAY AHP/LHP

CHECKED
KALLOL DAS

TITLE:
SOLID WASTE MANAGEMENT PLAN

APPROVED
GEORGE THAMBI

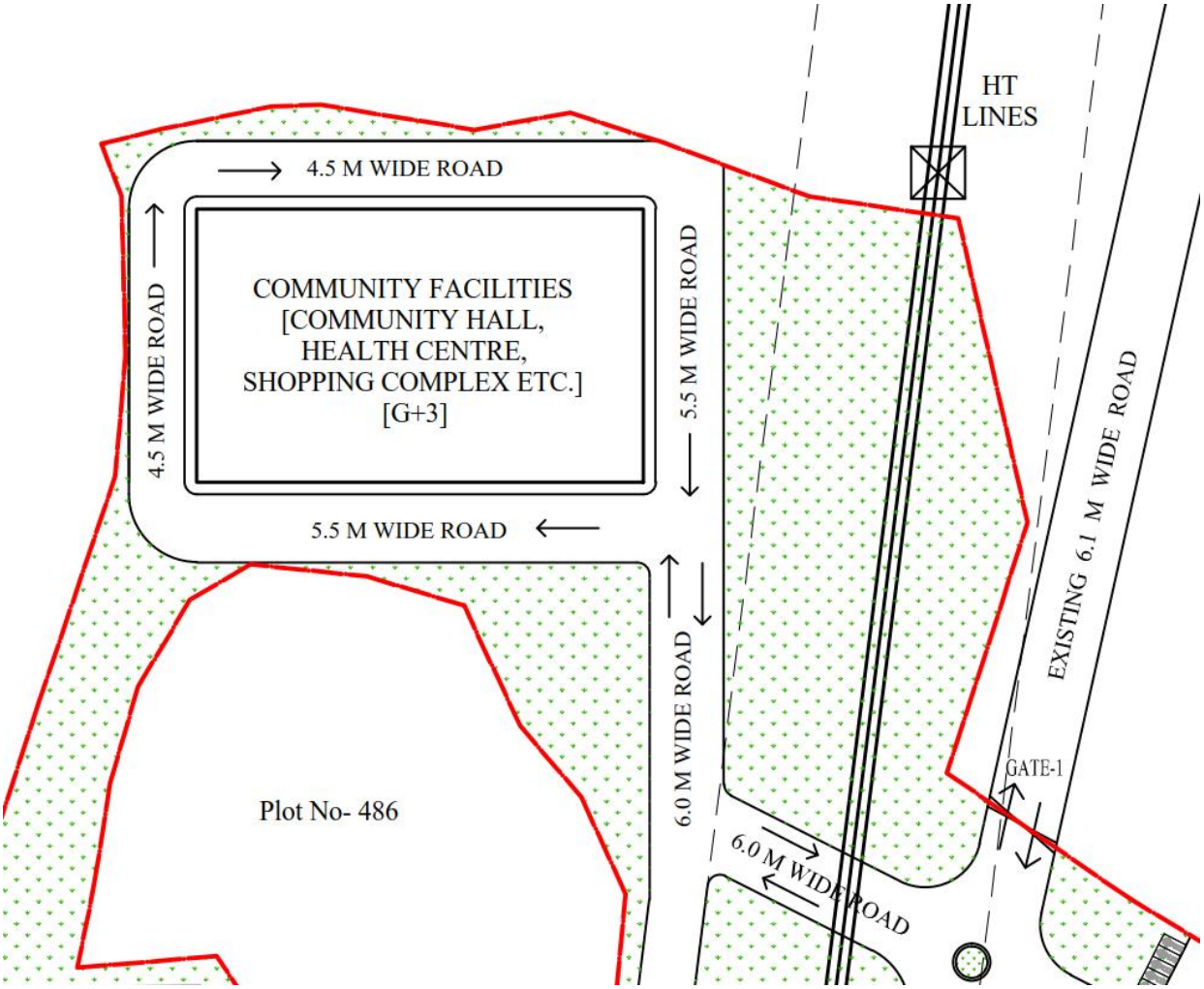
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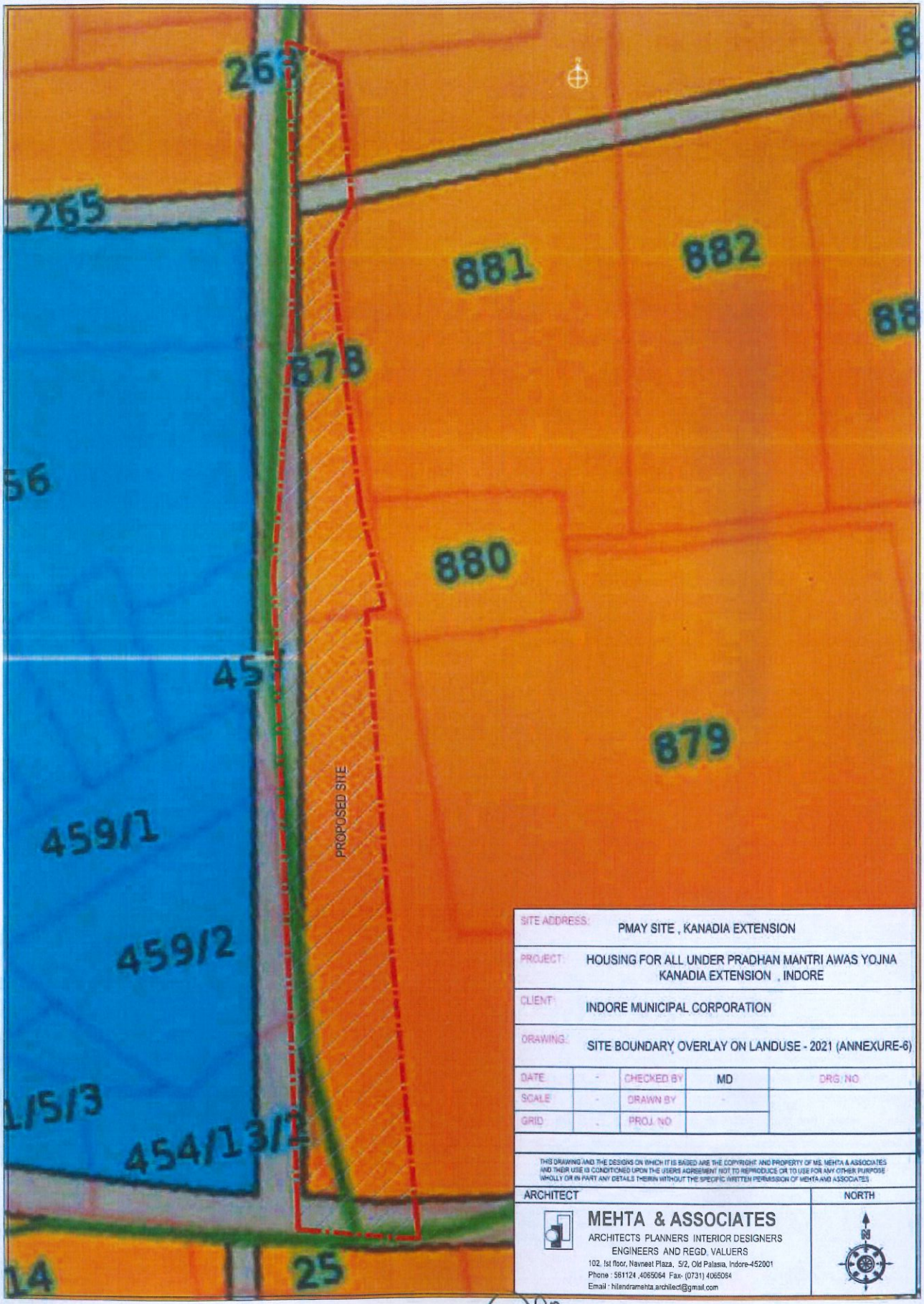
2.2.8 Social Infrastructure Building Drawings



2.3 LHP 3 Madhya Pradesh

2.3.1 Location Map





SITE ADDRESS:	PMAY SITE , KANADIA EXTENSION			
PROJECT:	HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA KANADIA EXTENSION , INDORE			
CLIENT:	INDORE MUNICIPAL CORPORATION			
DRAWING:	SITE BOUNDARY OVERLAY ON LANDUSE - 2021 (ANNEXURE-6)			
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SCALE	-	DRAWN BY	-	
GRID	-	PROJ. NO		

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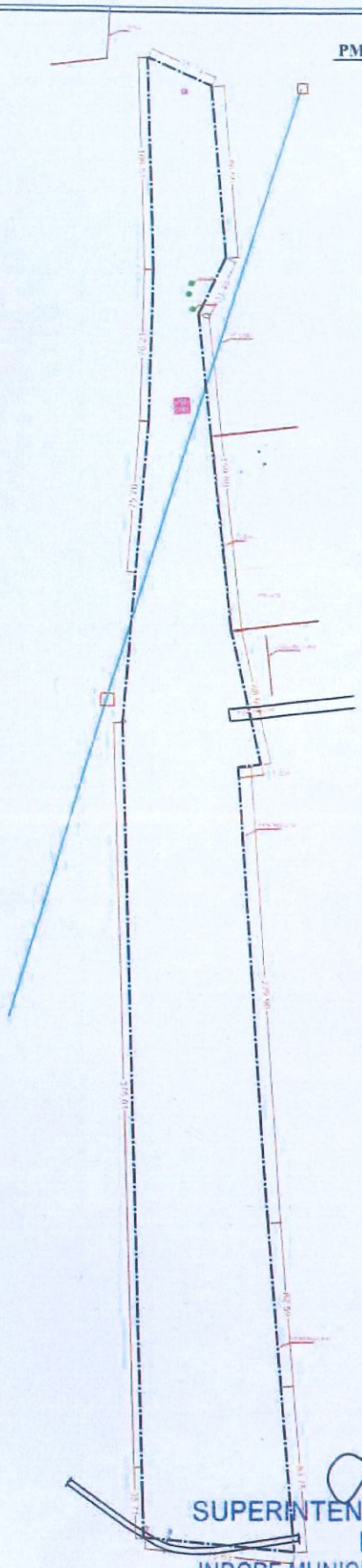
MEHTA & ASSOCIATES
ARCHITECTS PLANNERS INTERIOR DESIGNERS
ENGINEERS AND REGD. VALUERS
102, Ist floor, Navneet Plaza, 5/2, Old Palasia, Indore-452001
Phone : 561124 ,4065064 Fax- (0731) 4065064
Email : hilendramehta.architect@gmail.com

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INDORE MUNICIPAL CORPORATION

2.3.2 Total Station Survey Map

SURVEY PLAN FOR
PMAY, LAND AT VILLAGE- KANADIYA , DIST - INDORE (M.P.)



LEGENDS	
ELECTRIC TOWER	
TREE	
ELECTRIC LINE	
BT EDGE	
RASTA	
FENCING LINE	
CD	

SITE ADDRESS	PMAY SITE , KANADIA EXTENSION
PROJECT	HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA KANADIA EXTENSION , INDORE
CLIENT	INDORE MUNICIPAL CORPORATION
DRAWING	SURVEY PLAN

DATE		CHECKED BY		DRG. NO.
SCALE		DRAWN BY		
GRID		PROJ. NO.		

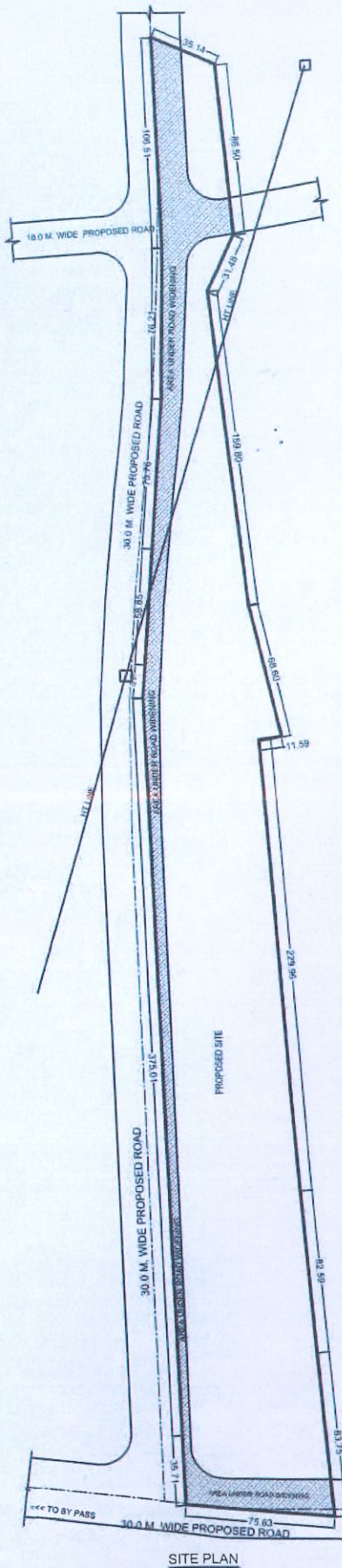
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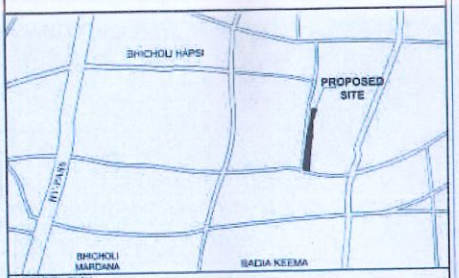
MEHTA & ASSOCIATES
ARCHITECTS PLANNERS INTERIOR DESIGNERS
ENGINEERS AND REGD. VALUERS
102, 1st floor, Navneet Plaza, 52, Old Palasia, Indore-452001
Phone : 9617828 4083064 Fax : (0731) 4065064
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HFA
INDORE MUNICIPAL CORPORATION



SITE PLAN



LOCATION PLAN

KHASRA DETAIL

S.NO.	OWNER	KHASRA NO.	AREA IN HECT.
1	GOVT. LAND	885/1/3	2.428
2	GOVT. LAND	878	1.764
	TOTAL AREA		4.192 HECT.

AREA STATEMENT

TOTAL LAND AREA	=	4.192 hect. (41920.00 sq.m.)
AREA UNDER ROAD WIDENING	=	7644.00 SQ.M
NET PLANNING AREA	=	34276.00 SQ.M

SITE ADDRESS: PMAY SITE , KANADIA EXTENSION

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA KANADIA EXTENSION , INDORE

CLIENT: INDORE MUNICIPAL CORPORATION

DRAWING: SITE PLAN

DATE	-	CHECKED BY	-	DRG. NO.
SCALE	-	DRAWN BY	-	
GRID	-	PROJ. NO		

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ARCHITECT

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INDORE MUNICIPAL CORPORATION

2.3.3 Soil Testing Report

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B-11, Navlakha Complex, Agrasen Square, Indore (M.P.) 452 001, India
Ph. : +91-731-4080977, Cell : +91-98935-66736, E-mail : index@indexlabindia.com

Test Report

ILC / TC / 2680/18-19 Format: F-5.1 0/T

The detailed scope of work was as per the instruction of Engineer in-charge. A complete geo-technical investigation work was undertaken to obtain the required subsurface information to study and define the nature and behavior of soil, under the application of loads of proposed structures. Such information was obtained through following steps:

- By making borehole and collecting disturbed soil samples.
- Conducting laboratory tests to classify it and to determine the engineering properties of soil.

An analysis was made to derive the allowable bearing capacity, taking into considerations the anticipated settlements and the present soil conditions with future possibilities. Based on such analysis of the soil properties, the conclusions are made regarding the precautions and protective measures to be taken, if found necessary.

This report has been prepared after a careful study of the field testing and laboratory test results. The type and depth of foundation are suggested.

Site Conditions:

Site Location: Kanadiya Near Impetus I.T. Park.

1.1 Sub Soil Profile: The field data and laboratory classification reveals, from 0 to 3.0 mtr Wheather Rock then 3.0 mtr to 15.0 mtr Rock.

2.0 Nature of Investigation:

2.1 Bore Holes: Boreholes were conducted by machinery drilling up to 15.0 mtrs depth below existing ground level. Boring was carried out in accordance with IS: 1892 – 1979 and the disturbed rock samples were collected in core box and sealed packed and brought to our laboratory at Indore for

Authorized Signatory
Pritesh Mahajan
(Technical Manager)

*This report is not valid without "INDEX" hologram

Terms & Conditions:

1. Subject to Indore Jurisdiction.
2. This Test Report refers only to the mentioned sample submitted in the laboratory. Samples are not drawn by us.
3. This report shall not be reproduced, except in full, without the written permission of CEO, Index Lab & Consultants, Indore.
4. This report is being issued on the specific understanding that Index Lab & Consultants will not in any way be involved in any action following the interpretation of the above results.

B-11, Navlakha Complex, Agrasen Square, Indore (M.P.) 452 001, India
Ph. : +91-731-4080977, Cell : +91-98935-66736, E-mail : index@indexlabindia.com

Test Report

further investigation.

2.2 **Recording of Water Table:** Water table is recorded after 24 hours of completion of the boreholes and after the analysis water table is not found.

2.3 **Sampling:** During the advancement of the boring Disturbed samples are collected up to 15.0 mtrs.

3.0 **Laboratory Tests:** Following laboratory tests were carried out to determine the Mechanical properties of disturbed soil samples. Detail procedures are explained in Annexure. I

(A) Field Dry Density & Field Moisture Content
(B) Atterberg's Limits
(C) Particle size distribution
(D) Shear Parameter
(E) Specific Gravity
(F) Free Swell Test

4.0 **Design:** Calculations for both Safe Bearing Capacity (SBC) and Safe Bearing Pressure (SBP) are carried out considering shear parameters and consolidation characteristics of the sub strata. Values of SBC & SBP are mentioned below:

4.1 **SBC Based on Shear:** The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with IS: 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C\,N_c\,S_c\,d_c\,i_c + q\,(N_q - 1)\,Sq\,d_q i_q + 0.5\,B\,N_r\,S_r\,d_r\,i_y\,w'$$

Where, C = Cohesion

Q = Overburden Pressure Density

B Width of the Foundation

N_c, N_q, N_r = Bearing Capacity Factor

Authorized Signatory
Pritesh Mahajan
(Technical Manager)

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Test Report

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S_c, S_q, S_r = Shape Factor

d_c, d_q, d_r = Depth Factor

i_c, i_a, i_y = Inclination Factor

W' = Correction Factor of Location of Water Table

4.2 **Safe Bearing Pressure :**(IS: 8009 Part I) The Settlement calculation involves many simplifying assumptions.

The total settlement is computed as summation of immediate and secondary settlement.

$$St = Si + Sc$$

Where, Si is Immediate Settlement

$$Si = p\ B\ \frac{(1 - \mu^2)}{E}\ I$$

Where, p = Foundation Pressure, kg/cm^2

B = Width of Footing, m

μ = Poisson's Ratio

I = Influence Factor

E = Modulus of Elasticity, kg/cm^2

Sc is Secondary Settlement

$$Sc = \frac{Ht}{(1+e_o)}\ Cc\ Log_{10}\ \frac{(po + p)}{po}$$

Where, Ht = Thickness of Soil Layer, m

Cc = Compression Index

Authorized Signatory
Pritesh Mahajan
(Technical Manager)

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e_o = Initial Void Ratio

po = Initial Effective Pressure

p = Increase in effective pressure

5.0 Guideline Properties of Rock Mass Classes

Class Description RMR Q Value	I Very good rock 100-81 >40	II Good rock 80-61 10-40	III Fair rock 60-41 4-10	IV Poor rock 40-21 1-4	V Very poor rock 20-0 <1
Friction angle ϕ (°)	>45	35-45	25-35	15-25	<15
Cohesion (kPa)	>400	300-400	200-300	100-200	<100
SBP (MPa)	10	4-6	1-2	0.5	<0.2
Safe cut slope (°)	>70	65	55	45	<40
Tunnel support	none	Spot bolts	Pattern bolts	Bolts + Shotcrete	Steel ribs
Stand up time for span	20 yr for 15 m	1 yr for 10m	1 wk for 5m	12h for 2 m	30 min for 1 m

General Shear Failure

$$q_{ult} = cN_c + 0.5\,\gamma B N_\gamma + \gamma D N_q$$

Where

q_{ult} = the ultimate bearing capacity

γ = effective unit weight (i.e. submerged unit wt. if below water table) of the rock mass

B = width of foundation

D = depth of foundation below ground surface

c = the cohesion intercepts for the rock mass

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Local Shear Failure

$q_{ult} = cN_c + 0.5\ \gamma BN_\gamma$

Compressive Failure:

A case characterized by poorly constrained columns of poor rock.

$q_{ult} = 2\ c \tan\ (45 + \phi / 2)$

Splitting Failure

For widely spaced and vertically oriented discontinuities, failure generally initiates by splitting beneath the foundation.

The ultimate bearing capacity is given by:

For circular foundations

$q_{ult} = JcN_{ct}$

For square foundations

$q = 0.85\ JcN_{ct}$

For continuous strip foundations for $L/B \leq 32$

$q_{ult} = JcN_{ct} / (22 + 0.18\ L/B)$

Where

J = correction factor dependent upon thickness of the foundation rock and width of foundation.

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L = length of the foundation

The bearing capacity factor N_{ct} is given by:

$$N_{ct} = \frac{2N\phi^2}{1+N_\phi} (\cot\phi)(S/B) \left[1 - \frac{1}{N_\phi}\right] - N\phi(\cot\phi) + 2N\phi^{1/2}$$

5.1 **Summary of Analysis:** Based on the field and laboratory test data allowable bearing capacity is derived for foundation with the consideration of following points.

5.1 The sub soil comprises of Soil & Rock.

5.2 Net bearing capacity is derived based shear parameters and UCS obtained from test conducted on remolded density.

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Table 1: Safe Bearing Capacity

Ground level for Bore No.1 (LIG), Kanadia Site is 102.670

Depth Below GL in Mtrs.	Ultimate Bearing Capacity, (T/m²)	Safe Bearing Capacity, (T/m²)
0.0 to 3.0 mtrs	67.8	27.1
3.0 to 4.5 mtrs	81.3	32.5
4.5 to 6.0 mtrs	89.0	35.6
6.0 to 7.5 mtrs	94.8	37.9
7.5 to 9.0 mtrs	101.5	40.6
9.0 to 10.5 mtrs	106.3	42.5
10.5 to 12.0 mtrs	111.8	44.7
12.0 to 13.5 mtrs	118.3	47.3
13.5 to 15.0 mtrs	126.0	50.4

6.0 Recommendations:

6.1 The Rock/Soil is suitable for footing purpose.

6.2 Safe bearing capacity of soil / rock at a different depth mention above for foundation. Settlement shall be within permissible limits.

General Note:

1. Factor of Safety considered is 2.5 for foundation.
2. The foundation shall in no mean rest on Filled up Soil or Black Cotton Soil.
3. If in the course of excavation, sub soil strata differs from the bore log strata same shall be reported for necessary steps.

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Annexure I

7.0 Sampling:

7.1.1 Disturbed Soil Samples: Disturbed samples were collected during the boring and also from the split spoon sampler. The samples recovered were logged, labeled and placed in polythene bags and sent to laboratory for testing. The samples collected up to 15.0 mtrs depth.

7.2 Laboratory Test Procedures:

7.2.1 Field Dry Density & Field Moisture Content: Field dry density and Field moisture content were carried out in accordance with I.S. 2720 Part-2 – 1983. The field density is found out by following equation. The value of F.D.D. & F.M.C. is shown in summary table -3.

Field Density (bulk) = Weight of soil mass / Volume of soil mass

And Field Dry Density = Bulk Density/ (1 + w), Where w is field moisture content.

7.2.2 Atterberg's Limit: Liquid limit and Plastic limits are carried out for the determination of different characteristic of soil. The tests performed in accordance with I.S.2720 Part – 5-1985 by using Mechanical Liquid Limit Apparatus. About 120 g of the soil sample passing 425-micron IS Sieve shall be mixed thoroughly with distilled water in the evaporating dish or on the flat glass plate to form a uniform paste. The paste shall have a consistency that will require 30 to 35 drops of the cup to cause the required closure of the standard groove.

Liquid limit and plastic limit of soils are both depend up on the amount and type of clay in a soil and form the basis for the soil classification system for cohesive soils based on the Plasticity index.

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For Plastic Limit, a soil sample weighing at least 20 gm of the soil sample passing 425 micron IS sieve is thoroughly mixed with water such that it can be easily molded with fingers. A ball is formed with about 8 gm of this soil and is rolled between the fingers and the glass plate with just sufficient pressure to roll the mass into a thread of uniform diameter of 3 mm throughout its length. The soil is kneaded to a uniform mass and rolled again. The process is continued until the thread crumbles. The pieces of crumbled soil thread are collected for moisture content determination and reported as plastic limit. Values of LL, PL & PI are shown in summary table.

7.2.3 Particle Size Distribution (IS: 2720 Part IV): The sieve analysis is carried out in accordance with IS. The results are shown in the summary table.

7.2.4 Specific Gravity (IS: 2720 Part III): In order to determine specific gravity of soil particles these tests were conducted on Selected samples in 50 ml volumetric density bottle using procedure described in IS. The value of Specific Gravity is shown in summary table.

7.2.5 Direct Shear Test (IS: 2720 Part XIII): Direct shear test is carried out using shear box with the specimens (60mm x 60mm). Specimen with plain grid plate at the bottom of the specimen and plain grid plate at the top of the specimen is fitted into position in the shear box housing and assembly placed on the load frame. The serrations of the grid plates are kept at the right angle to the direction of shear. Loading pad is placed on top grid plate. The required normal stress is applied and the rate of

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Test Report

longitudinal displacement / shear stress application so adjusted that no drainage can occur in the sample during the test (1.25mm/min). The upper part of the shear box is raised such that a gap of about 1mm is left between the two parts of the box. Test is conducted by applying horizontal shear load to failure or to 20 percent longitudinal displacement whichever occurs first. Test is repeated on identical specimens. The shear parameters obtained from the shear stress Vs normal stress plot. Direct Shear Test is conducted on remolded samples at FDD & FMC.

7.2.6 **Free Swell test (IS: 2720 (Part – XL):** In order to determine the swelling characteristics of the soil, differential free swell test is carried out. An oven dried soil sample, 10 gm passing through 425 micron is poured in two 100 ml graduated cylinder. One cylinder was filled with distilled water and in kerosene up to 100 ml mark. After the removal of entrapped air, sample was allowed sufficient time to attain equilibrium state of volume. The final volume of soil in each cylinder was recorded.

Free Swell Index (FSI)

$$FSI\ \% = \frac{\text{Soil volume in water} - \text{Soil volume in kerosene}}{\text{Soil volume in kerosene}} \times 100$$

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Shear by Triaxial as per IS: 2720 (Part XII)-1981:

The test should be conducted in environment in which ambient temperature is constant. All valves are assumed to be closed and it is also assumed that the pedestal at the base of triaxial cell is covered with water. Gently slide one de-aired coarse porous stone on to the top of the pedestal and blow off any excess water from the pedestal. Place a filter paper disc on the stone and then place the soil sample on the disc. Place the second de-aired disc and the coarse porous stone on top of the sample and the loading cap on top of the second porous stone. Ensure that the sample, the stones, the discs, and the loading cap are all concentrically placed on the pedestal.

Strength of Intact Rock Material (MPa)			
	Compressive Strength	Point Load Strength	Rating
Exceptionally Strong	>250	>8	15
Very Strong	100-250	4-8	12
Strong	50-100	2-4	7
Average	25-50	1-2	4
Weak	10-25	Use of uni axial compressive strength is preferred	2
Very Weak	2-10		1
Extremely Weak	<2		0

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Table – 2 BORE LOG (As per I.S. 1892: 1979)

Depth in Mtr. From EGL	Description of Strata	Soil Legend	Nature of Sample	SPT Value/RR-RQD
0.0 to 3.0 Mtr	Rock		RR/RQD	35cm/Nil
3.0 to 4.5 mtrs	Rock		RR/RQD	60cm/Nil
4.5 to 6.0 mtrs	Rock		RR/RQD	74cm/Nil
6.0 to 7.5 mtrs	Rock		RR/RQD	82cm/30cm
7.5 to 9.0 mtrs	Rock		RR/RQD	94cm/48cm
9.0 to 10.5 mtrs	Rock		RR/RQD	105cm/62cm
10.5 to 12.0 mtrs	Rock		RR/ RQD	126cm/74cm
12.0 to 13.5 mtrs	Rock		RR/ RQD	132cm/82cm
13.5 to 15.0 mtrs	Rock		RR/ RQD	138cm/93cm

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SBC of Rock as per IS: 12070 - 1987

	Depth Mtr.	Water Absorption	Dry Density	Net SBC T/m²
Bore No.1	0.0 to 3.0 mtrs	1.48	2.57	27.1
	3.0 to 4.5 mtrs	1.26	2.60	32.5
	4.5 to 6.0 mtrs	1.00	2.66	35.6
	6.0 to 7.5 mtrs	0.74	2.73	37.9
	7.5 to 9.0 mtrs	0.68	2.80	40.6
	9.0 to 10.5 mtrs	0.65	2.82	42.5
	10.5 to 12.0 mtrs	0.63	2.85	44.7
	12.0 to 13.5 mtrs	0.60	2.89	47.3
	13.5 to 15.0 mtrs	0.56	2.91	50.4

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Glossary

Abbreviations	Descriptions
BC	Black Cotton
BH	Bore Hole
SBC	Safe Bearing Capacity
T	Tone
SPT	Standard Penetration Test
UDS	Undisturbed Sample
DS	Disturbed Sample
G	Gravel
S	Sand
M	Silt
C	Clay
LL	Liquid Limit
PL	Plastic Limit
PI	Plasticity Index
FDD	Field Dry Density
NMC	Natural Moisture Content
C	Cohesion
Ø	Angle of Internal Friction
SL	Shrinkage Limit
FSI	Free Swell Index
RMR	Rock Mass Rating
RR	Rock Recovery

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RQD	Rock Quality Designation
FMC	Field Moisture Content
SG	Specific Gravity
NA	Not Applicable

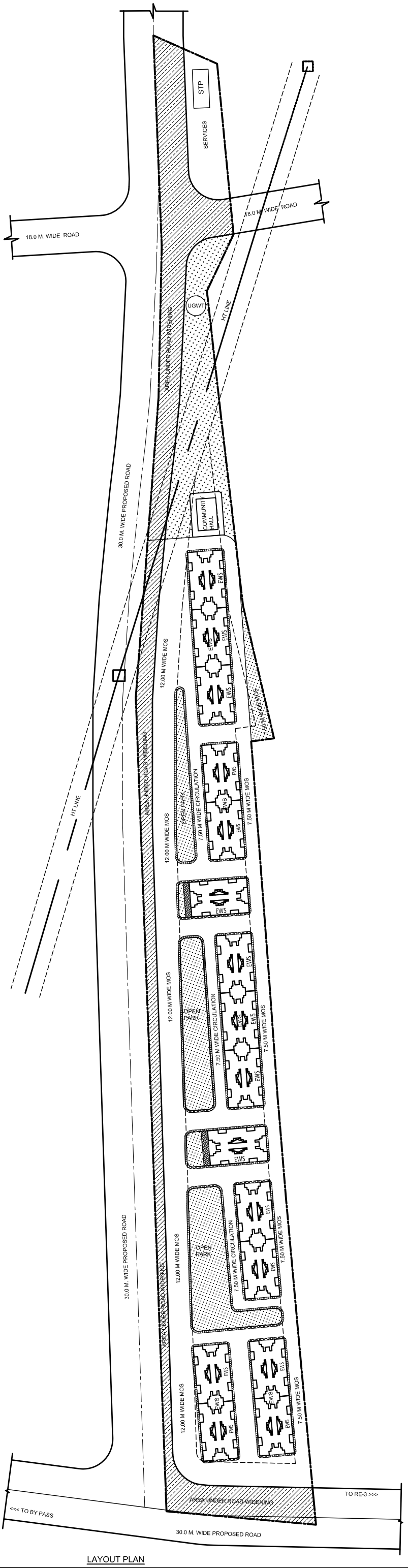
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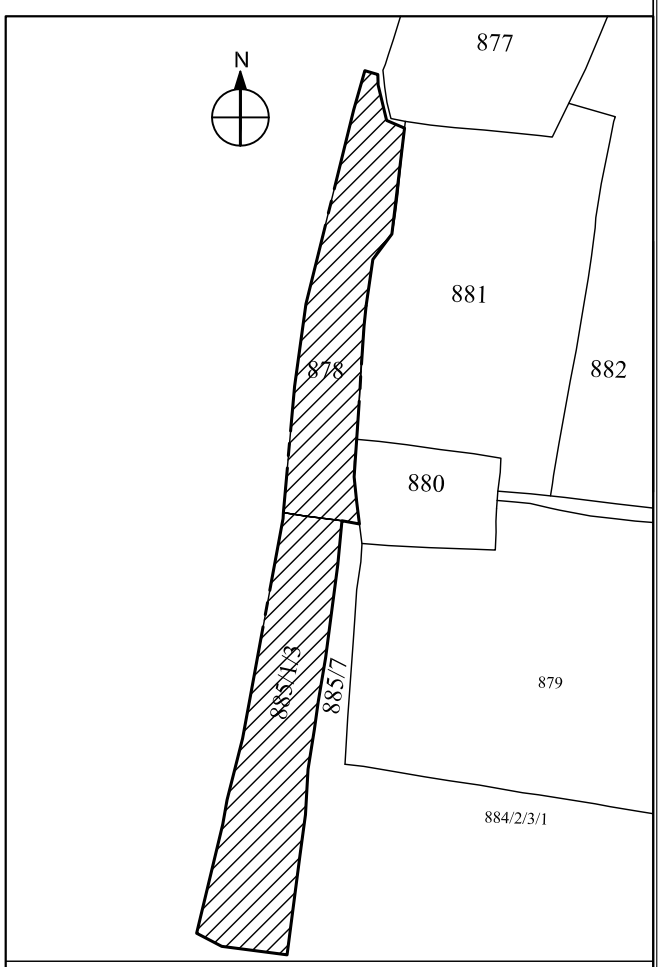
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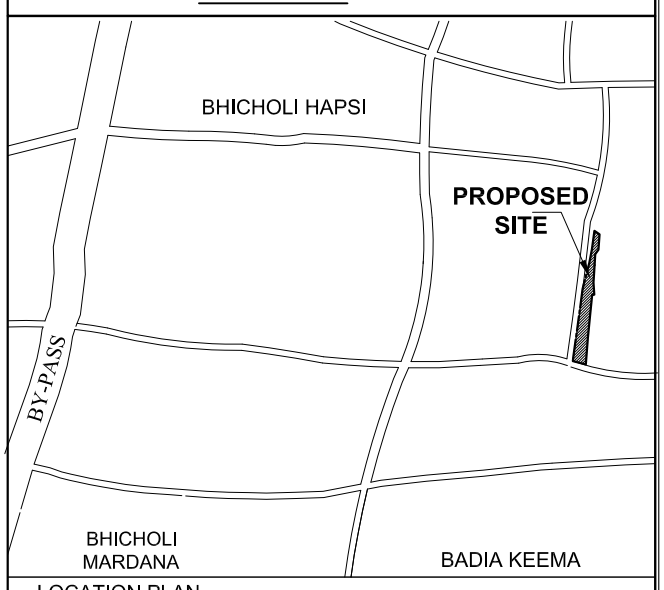
2.3.4 Layout Plan



LAYOUT PLAN



KHASRA PLAN



LOCATION PLAN

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

CLIENT - INDORE MUNICIPAL CORPORATION

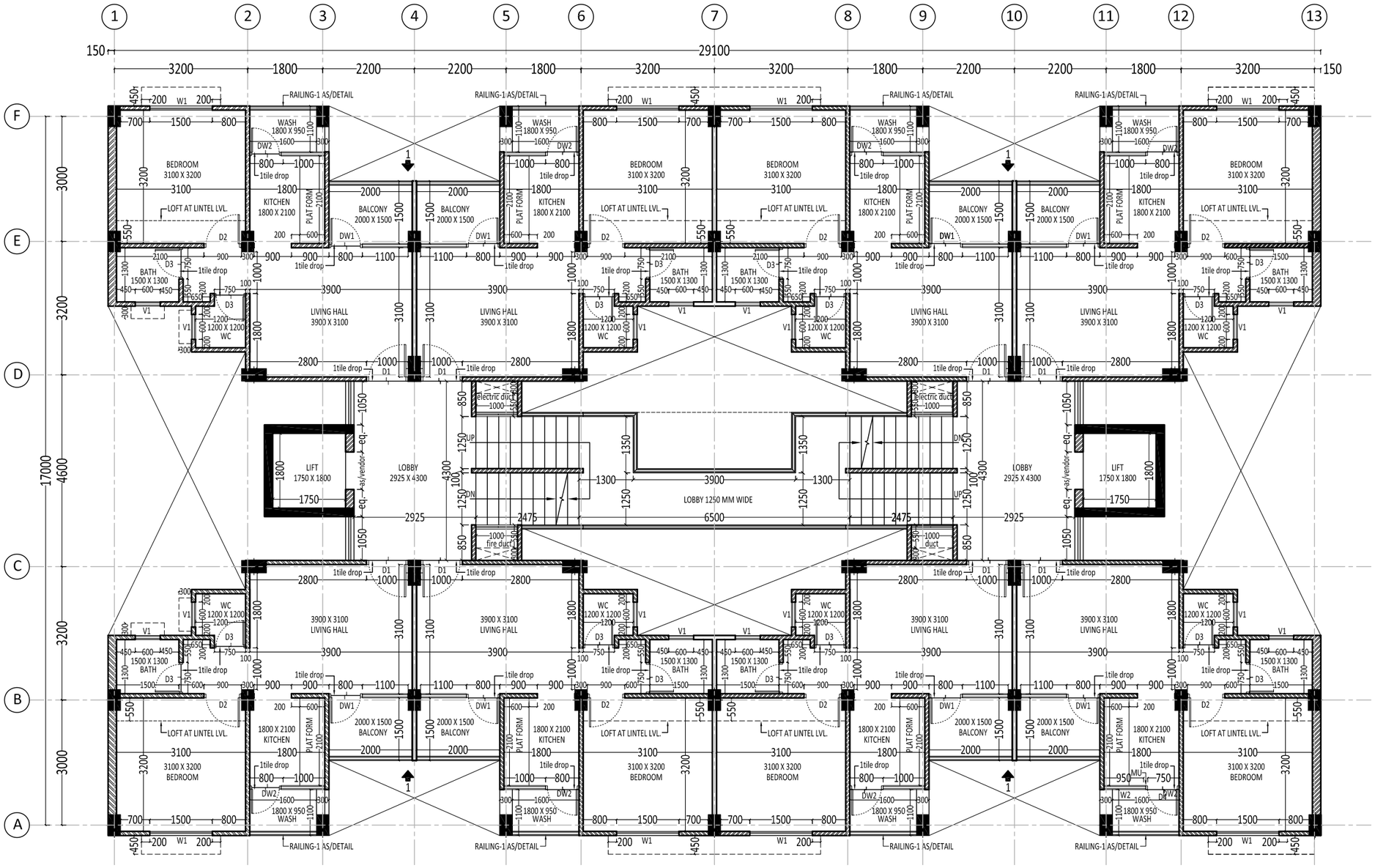
DRAWING - LAYOUT PLAN (KANADIYA EXTENSION)

DRG N0 - LAY-01

SCALE - N.T.S.

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2.3.6 Floor Plans



TYPICAL (1ST,3rd,5th&7th) FLOOR PLAN

DOORS			
S.NO.	TYPE	SIZE	DESCRIPTION
1.	D1	1000 x till beam bottom	FLUSH DOOR (WOODEN FRAME)
2.	D2	900 x 2150	FLUSH DOOR (PRESSED STEEL FRAME)
3.	D3	750 x 2150	FLUSH DOOR (PRESSED STEEL FRAME)
4.	D4	750 x till beam bottom	ALUMINIUM DOOR
5.	D5	1000 x 2150	MS DOOR TERRACE
6.	D6	1000 x 1500	ELECTRIC DOOR
7.	D7	1000 x 1500	FIRE DOOR

WINDOWS & VENTILATOR			
S.NO.	TYPE	SIZE	DESCRIPTION
1.	W1	1500Xtill beam bottom	ALUMINIUM WINDOW
2.	W2	950Xtill beam bottom	ALUMINIUM WINDOW
3.	W3	1000Xtill beam bottom	ALUMINIUM WINDOW
4.	V1	600X600	ALUMINIUM LOUVERED

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

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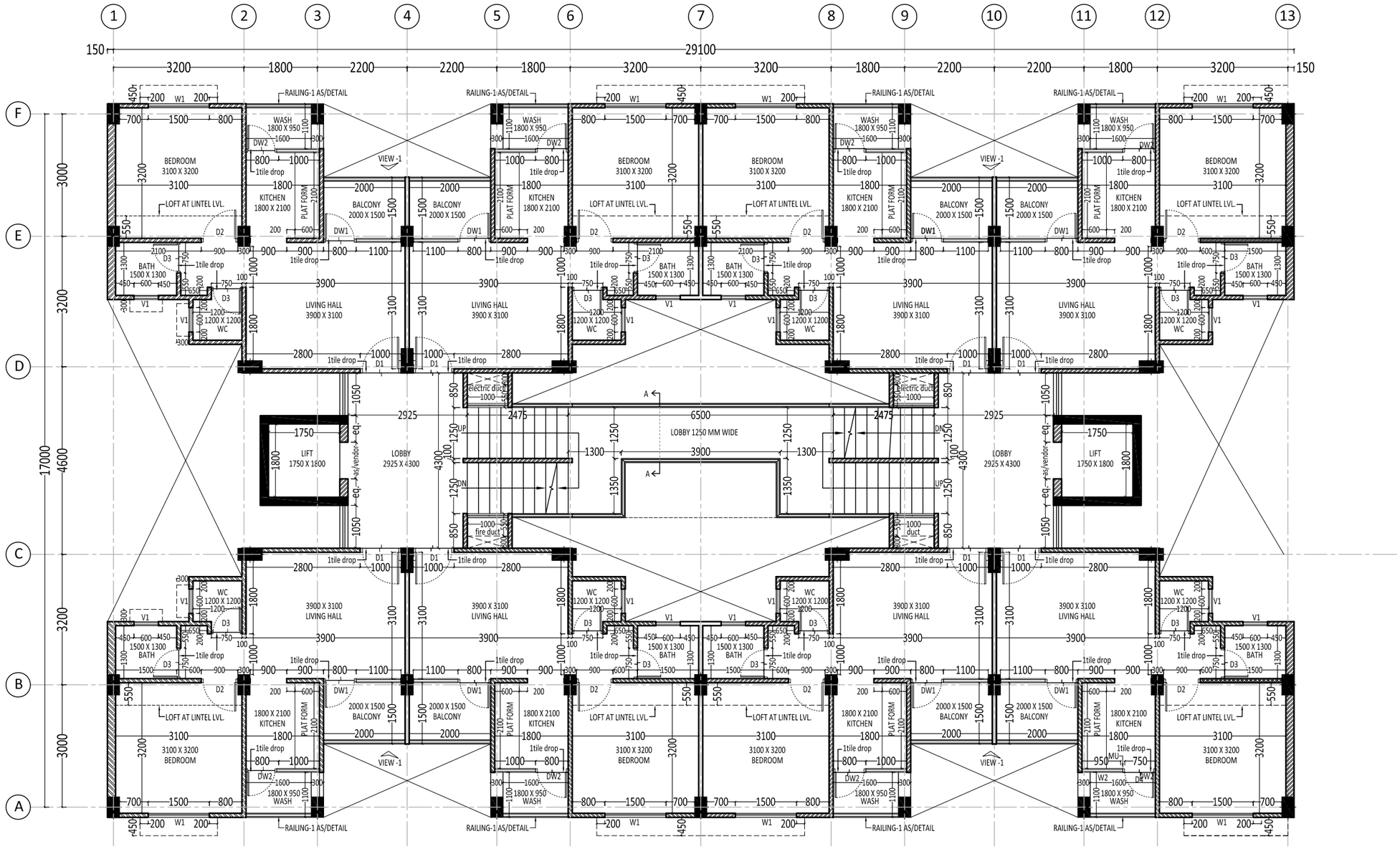
DRAWING - TYPICAL 1ST, 3RD, 5TH & 7TH FLOOR PLAN - EWS BLOCK (KANADIYA EXTENSION)

387

DRG NO - AR-03

SCALE - N.T.S.

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TYPICAL (2nd, 4th, 6th&8th) FLOOR PLAN

DOORS			
S.NO.	TYPE	SIZE	DESCRIPTION
1.	D1	1000 x till beam bottom	FLUSH DOOR (WOODEN FRAME)
2.	D2	900 x 2150	FLUSH DOOR (PRESSED STEEL FRAME)
3.	D3	750 x 2150	FLUSH DOOR (PRESSED STEEL FRAME)
4.	D4	750 x till beam bottom	ALUMINIUM DOOR
5.	D5	1000 x 2150	MS DOOR TERRACE
6.	D6	1000 x 1500	ELECTRIC DOOR
7.	D7	1000 x 1500	FIRE DOOR

WINDOWS & VENTILATOR			
S.NO.	TYPE	SIZE	DESCRIPTION
1.	W1	1500Xtill beam bottom	ALUMINIUM WINDOW
2.	W2	950Xtill beam bottom	ALUMINIUM WINDOW
3.	W3	1000Xtill beam bottom	ALUMINIUM WINDOW
4.	V1	600X600	ALUMINIUM LOUVERED

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

CLIENT - INDORE MUNICIPAL CORPORATION

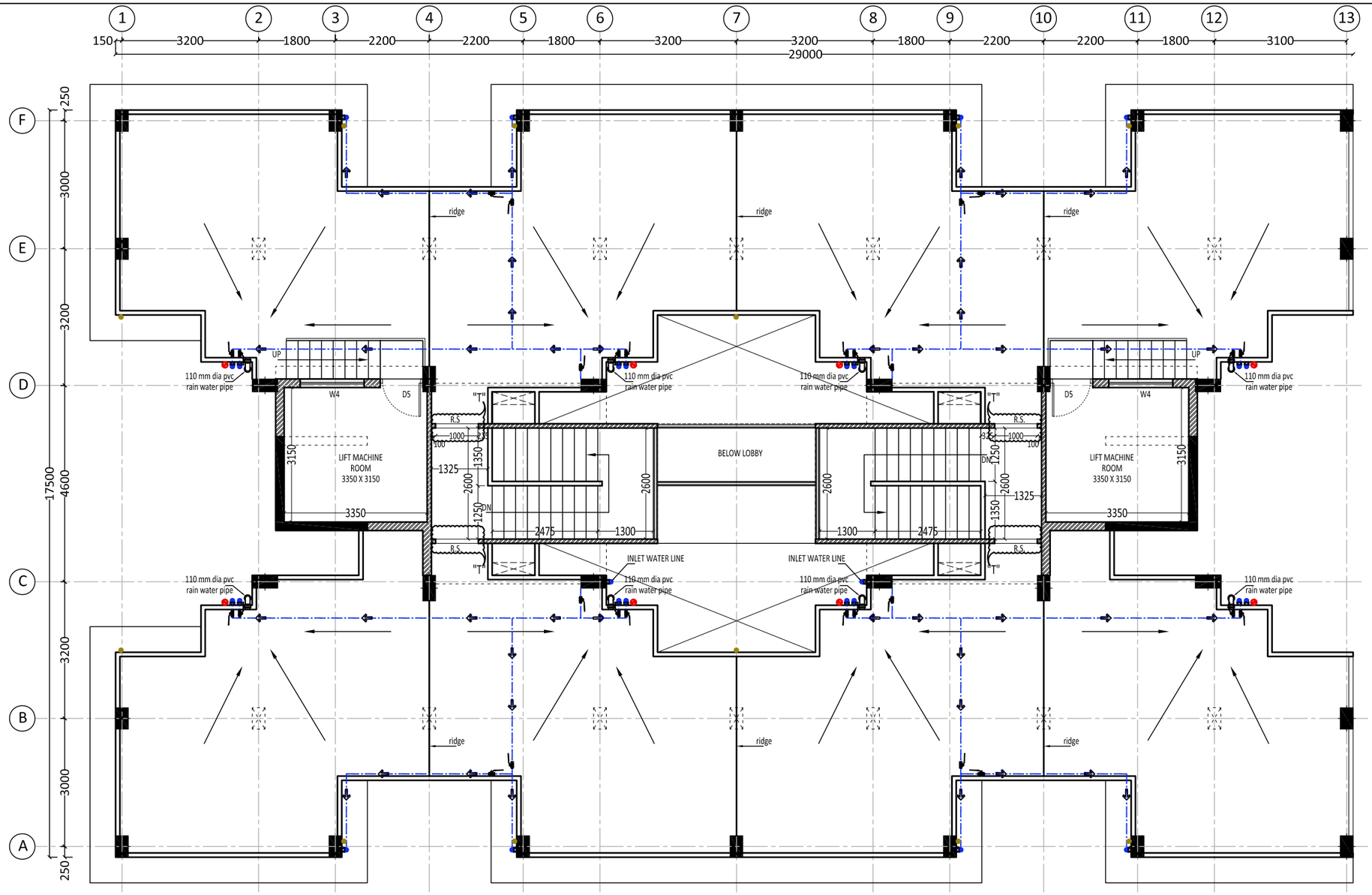
DRAWING - TYPICAL 2ND,4TH,6TH & 8TH FLOOR PLAN - EWS BLOCK (KANADIYA EXTENSION)

388

DRG NO - AR-04

SCALE - N.T.S.

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TERRACE PLAN

DOORS			
S.NO.	TYPE	SIZE	DESCRIPTION
1.	D1	1000 x till beam bottom	FLUSH DOOR (WOODEN FRAME)
2.	D2	900 x 2150	FLUSH DOOR (PRESSED STEEL FRAME)
3.	D3	750 x 2150	FLUSH DOOR (PRESSED STEEL FRAME)
4.	D4	750 x till beam bottom	ALUMINIUM DOOR
5.	D5	1000 x 2150	MS DOOR TERRACE
6.	D6	1000 x 1500	ELECTRIC DOOR
7.	D7	1000 x 1500	FIRE DOOR

WINDOWS & VENTILATOR			
S.NO.	TYPE	SIZE	DESCRIPTION
1.	W1	1500Xtill beam bottom	ALUMINIUM WINDOW
2.	W2	950Xtill beam bottom	ALUMINIUM WINDOW
3.	W3	1000Xtill beam bottom	ALUMINIUM WINDOW
4.	V1	600X600	ALUMINIUM LOUVERED

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

CLIENT - INDORE MUNICIPAL CORPORATION

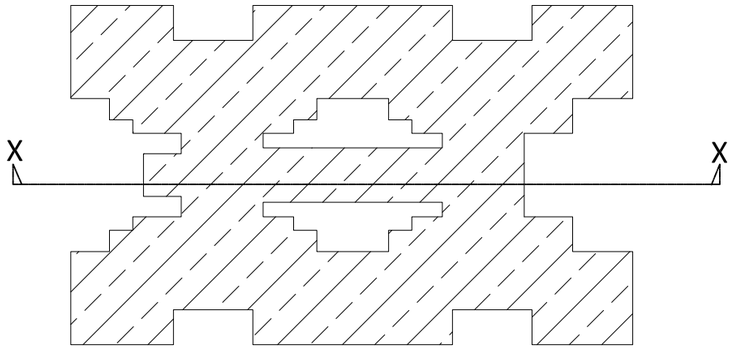
DRAWING - TERRACE FLOOR PLAN - EWS BLOCK (KANADIYA EXTENSION)

389

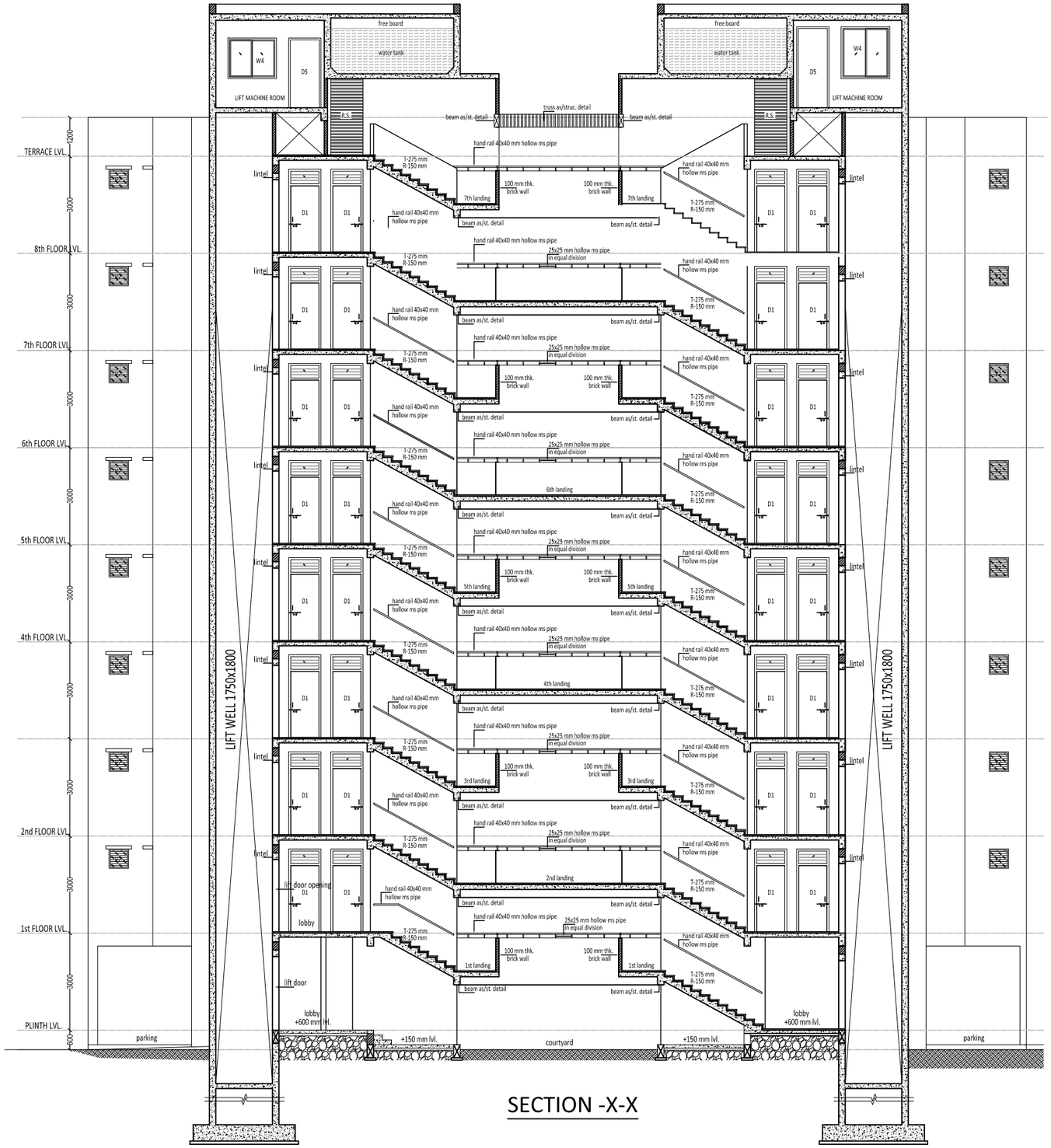
DRG NO - AR-05

SCALE - N.T.S.

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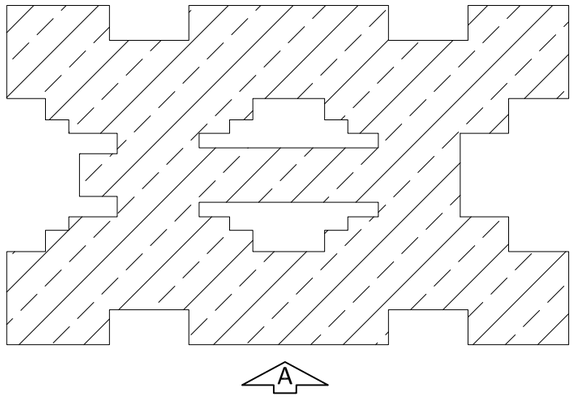
KEY PLAN



SECTION -X-X

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE	DRG N0 - AR-06
CLIENT - INDORE MUNICIPAL CORPORATION	SCALE - N.T.S.
DRAWING - SECTION - EWS BLOCK (KANADIYA EXTENSION) 390	

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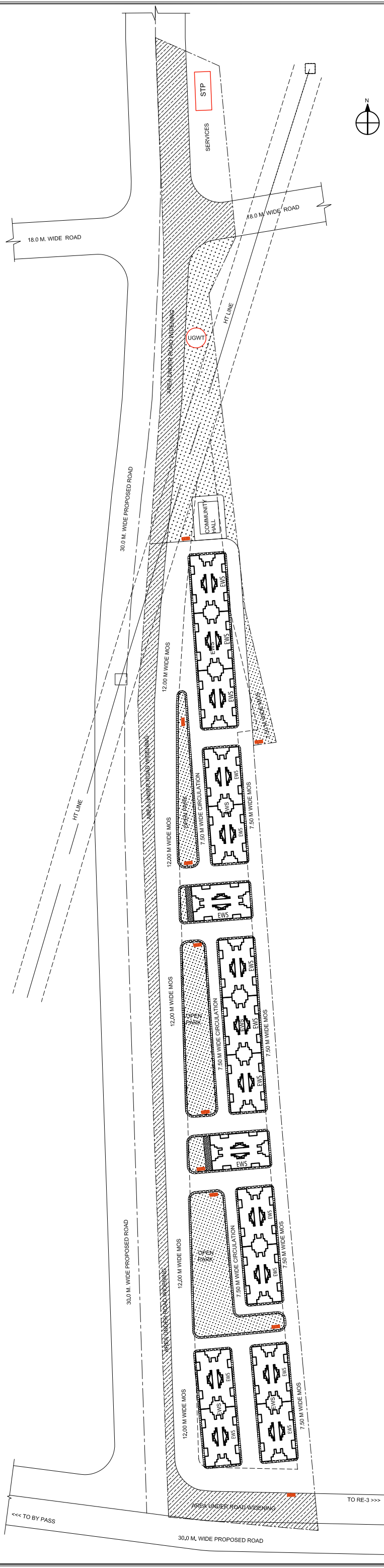


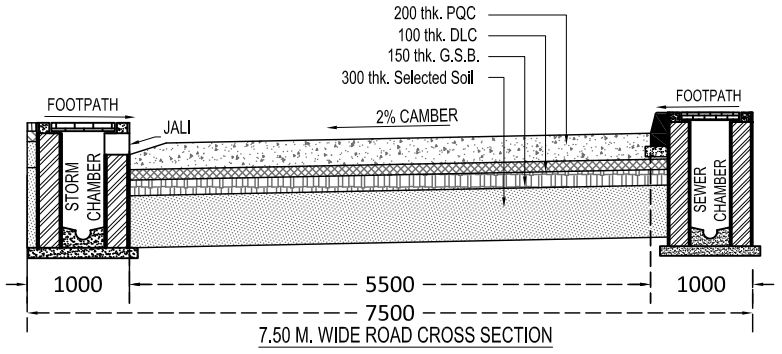
KEY PLAN



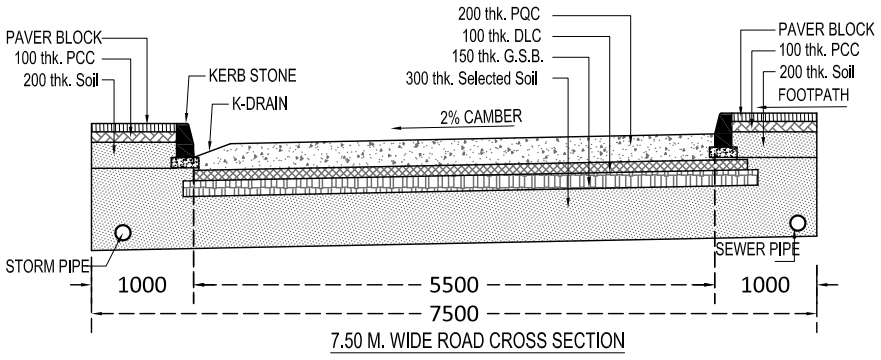
ELEVATION - A

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE	DRG N0 - AR-07	**MEHTA & ASSOCIATES**
CLIENT - INDORE MUNICIPAL CORPORATION	SCALE - N.T.S.	ARCHITECTS PLANNERS PROJECT CONSULTANT
DRAWING - FRONT ELEVATION - EWS BLOCK (KANADIYA EXTENSION) 391		102. 1st floor, Navneet Plaza, 5/2, Old Palasia, Indore-452001 Phone : 2561124 ,4065064 Fax- (0731) 4065064 Email : hitendramehta.architect@gmail.com

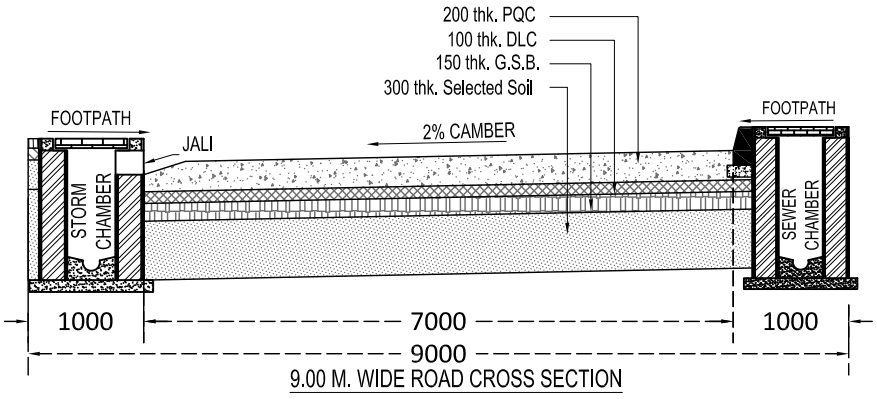




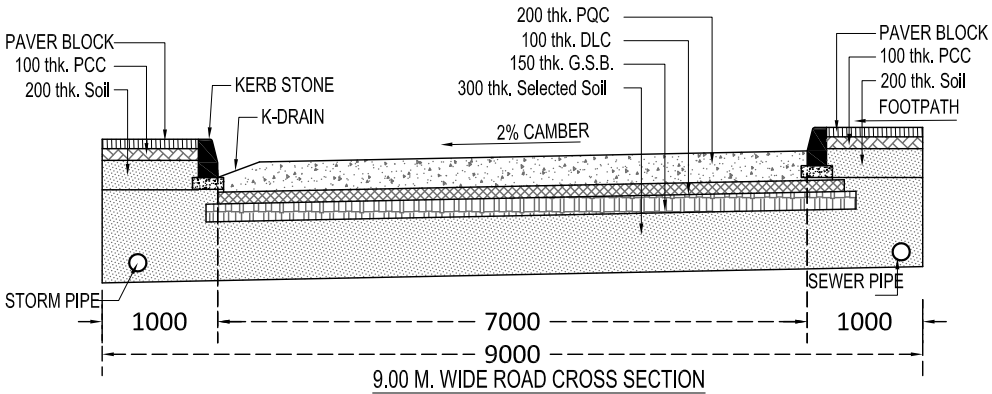
7.50 M. WIDE ROAD CROSS SECTION



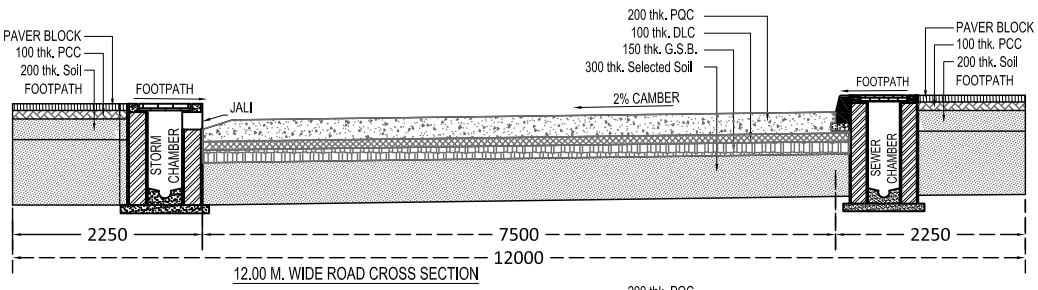
7.50 M. WIDE ROAD CROSS SECTION



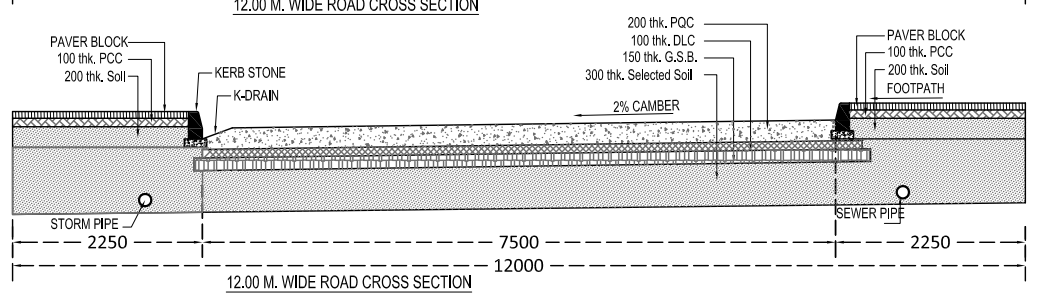
9.00 M. WIDE ROAD CROSS SECTION



9.00 M. WIDE ROAD CROSS SECTION



12.00 M. WIDE ROAD CROSS SECTION



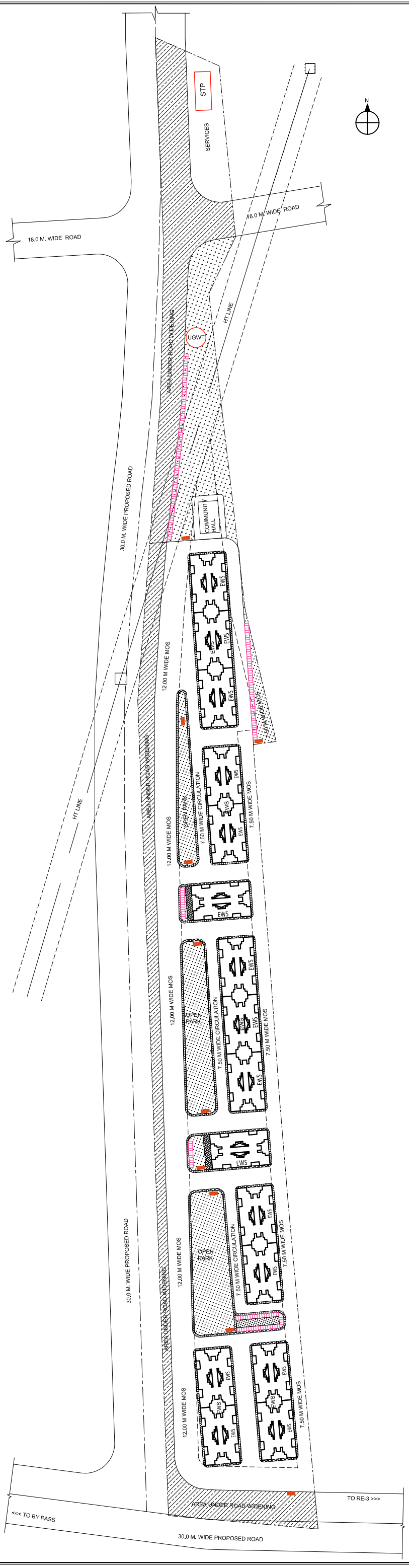
12.00 M. WIDE ROAD CROSS SECTION

LEGEND :

DUSTBIN

PROJECT -	HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE
CLIENT -	INDORE MUNICIPAL CORPORATION
DRAWING -	ROAD LAYOUT (KANADIYA EXTENSION)
DRG N0 -	OD-01
SCALE -	N.T.S.

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LEGEND :

PARKING

DUSTBIN

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

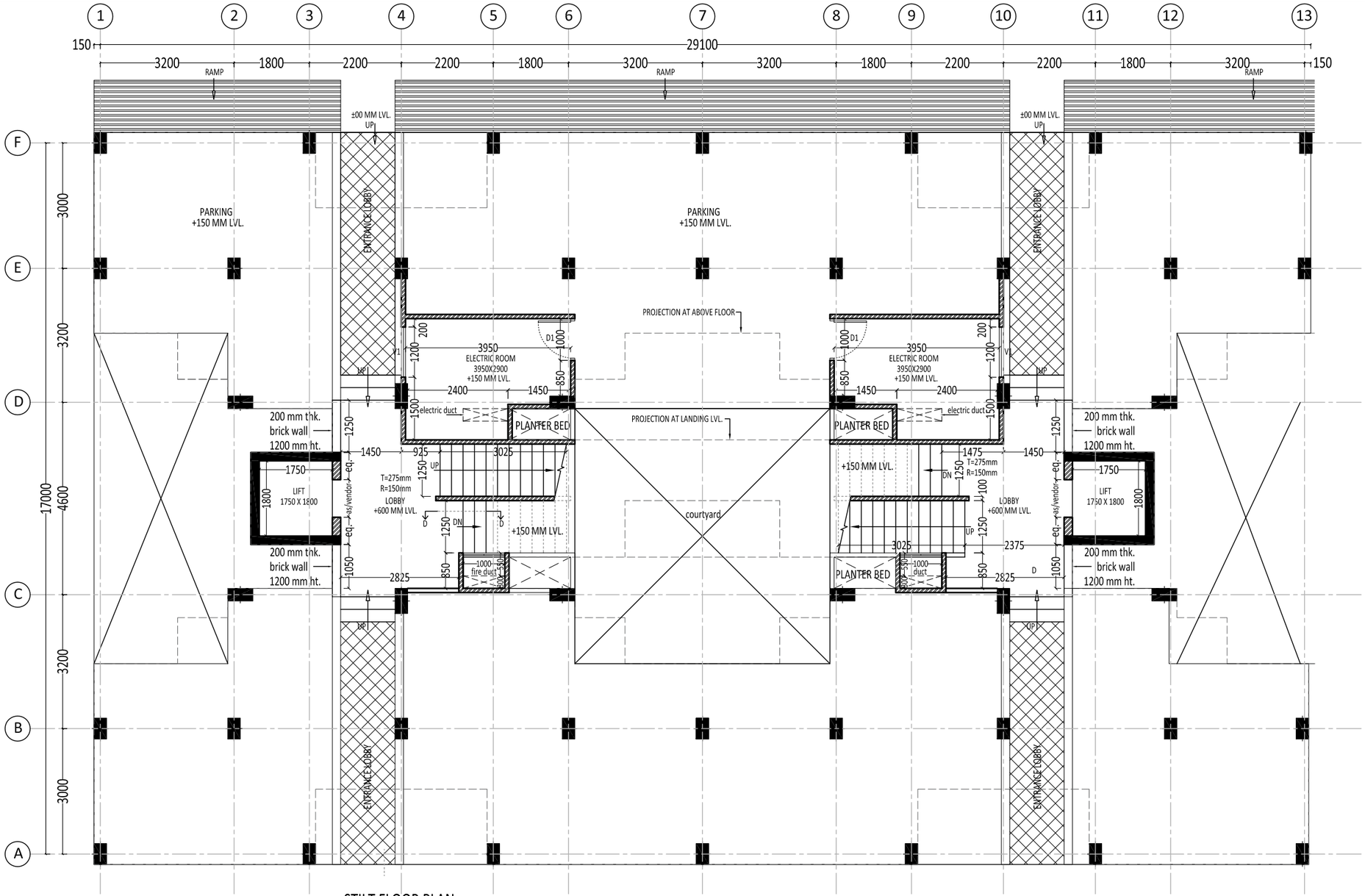
CLIENT - INDORE MUNICIPAL CORPORATION

DRAWING - PARKING LAYOUT PLAN (KANADIYA EXTENSION)

DRG N0 - PKG-01

SCALE - N.T.S.

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STILT FLOOR PLAN

DOORS			
S.NO.	TYPE	SIZE	DESCRIPTION
1.	D1	1000 x till beam bottom	FLUSH DOOR (WOODEN FRAME)
2.	D2	900 x 2150	FLUSH DOOR (PRESSED STEEL FRAME)
3.	D3	750 x 2150	FLUSH DOOR (PRESSED STEEL FRAME)
4.	D4	750 x till beam bottom	ALUMINIUM DOOR
5.	D5	1000 x 2150	MS DOOR TERRACE
6.	D6	1000 x 1500	ELECTRIC DOOR
7.	D7	1000 x 1500	FIRE DOOR

WINDOWS & VENTILATOR			
S.NO.	TYPE	SIZE	DESCRIPTION
1.	W1	1500Xtill beam bottom	ALUMINIUM WINDOW
2.	W2	950Xtill beam bottom	ALUMINIUM WINDOW
3.	W3	1000Xtill beam bottom	ALUMINIUM WINDOW
4.	V1	600X600	ALUMINIUM LOUVERED

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

CLIENT - INDORE MUNICIPAL CORPORATION

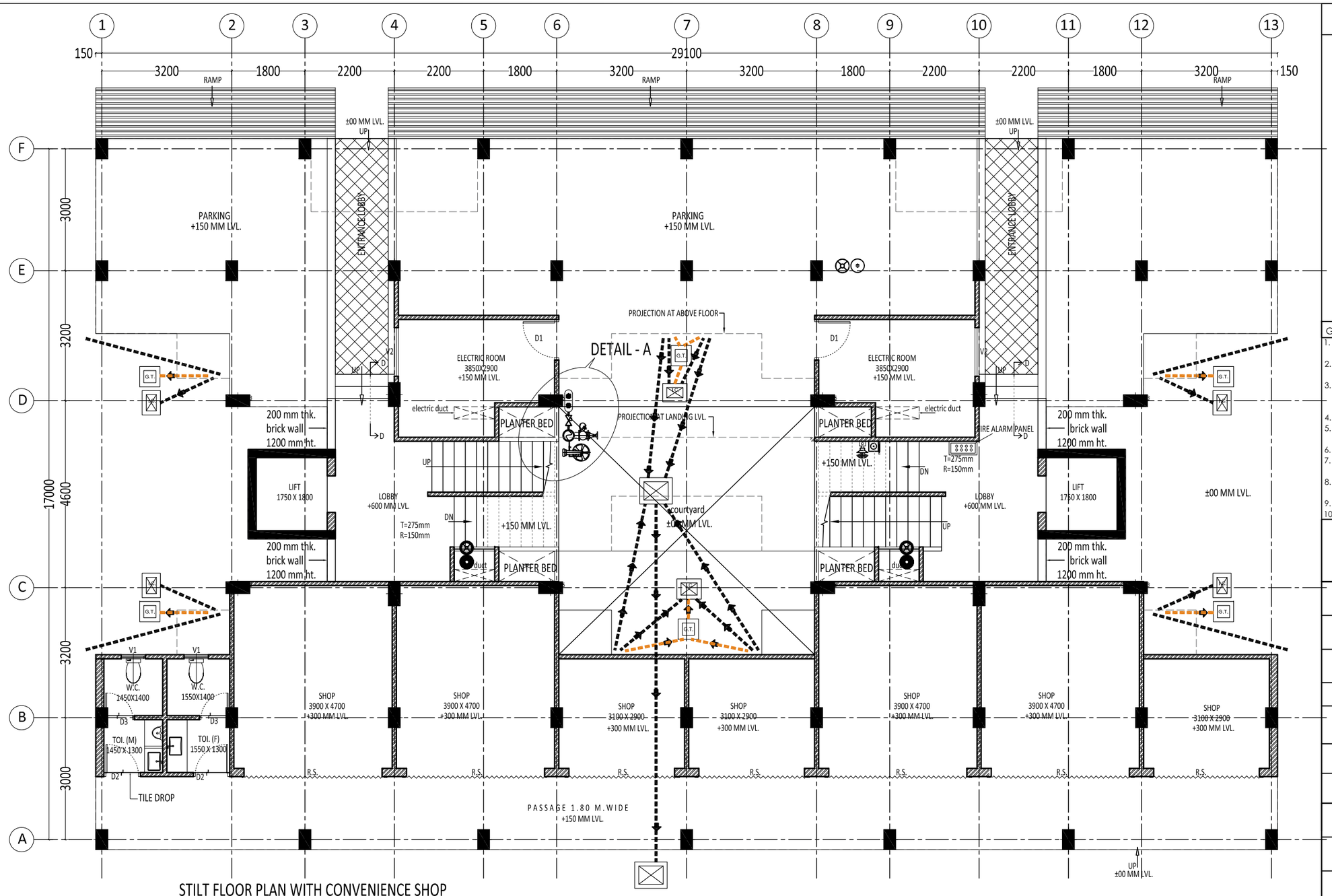
DRAWING - STILT FLOOR PLAN - EWS BLOCK (KANADIYA EXTENSION)

DRG NO - AR-02

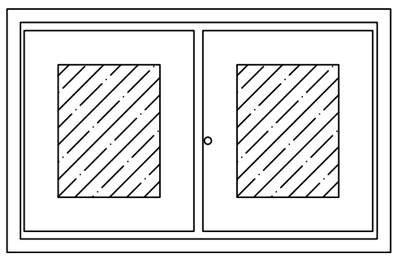
SCALE - N.T.S.

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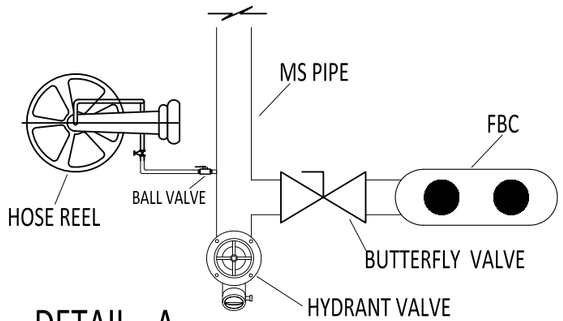
2.3.7 Physical Infrastructure Drawings



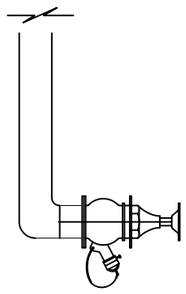
STILT FLOOR PLAN WITH CONVENIENCE SHOP



HOSE BOX DETAIL



DETAIL - A



HYDRANT DETAIL

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8. EMBEDDED PLATE SHALL BE PROVIDED AT LINTEL LVL. WHERE DOOR / WINDOW IS ADJOINING TO COLUMN.
9. PERIPHERAL PLINTH PROTECTION AS / TENDER ITEM.
10. ALL DIM. ARE IN MM.

LEGEND

	MANUAL CALL POINT
	HOOTER
	HOSE REEL
	M.S. HYDRANT PIPE
	SINGLE HEADED HYDRANT VALVE
	BUTTER FLY VALVE
	CO2 TYPE FIRE EXT
	ABC STORED PRESUURE FE
	MECHANICAL FOAM TYPE FE
	WATER CO2 TYPE FIRE EXT
	2-WAY FIRE BRIDGE CONNECTION

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

DRAWING: STILT FLOOR PLAN WITH CONVENIENCE SHOP (KANADIYA EXTENSION)

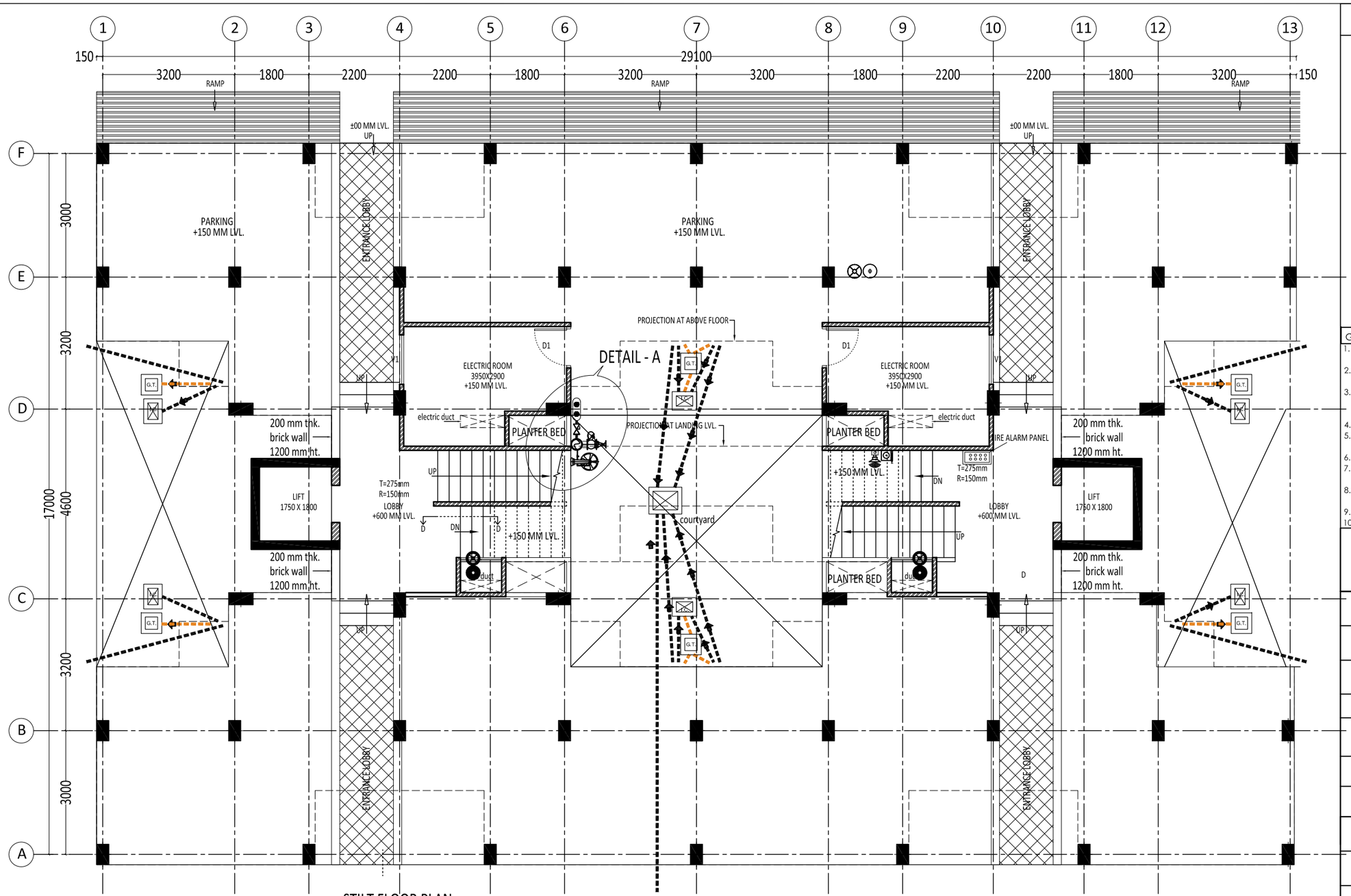
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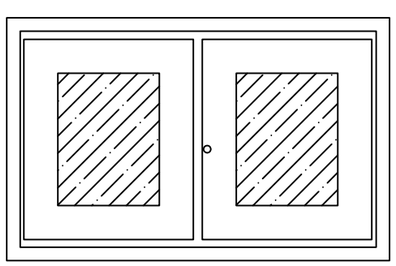
STILT FLOOR PLAN

GENERAL NOTES

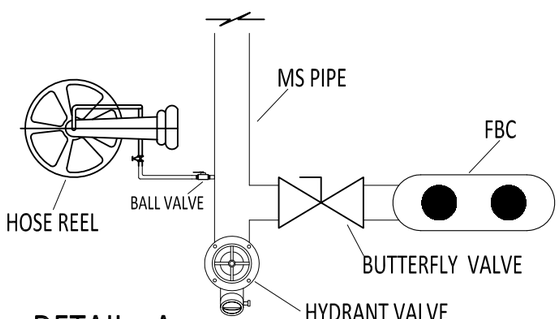
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9. PERIPHERAL PLINTH PROTECTION AS / TENDER ITEM.
10. ALL DIM. ARE IN MM.

LEGEND

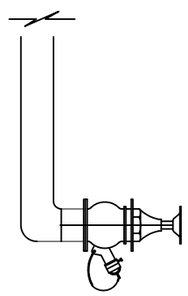
	MANUAL CALL POINT
	HOOTER
	HOSE REEL
	M.S. HYDRANT PIPE
	SINGLE HEADED HYDRANT VALVE
	BUTTER FLY VALVE
	CO2 TYPE FIRE EXT
	ABC STORED PRESUURE FE
	MECHANICAL FOAM TYPE FE
	WATER CO2 TYPE FIRE EXT
	2-WAY FIRE BRIDGE CONNECTION



HOSE BOX DETAIL



DETAIL - A



HYDRANT DETAIL

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

DRAWING: STILT FLOOR PLAN (KANADIYA EXTENSION)

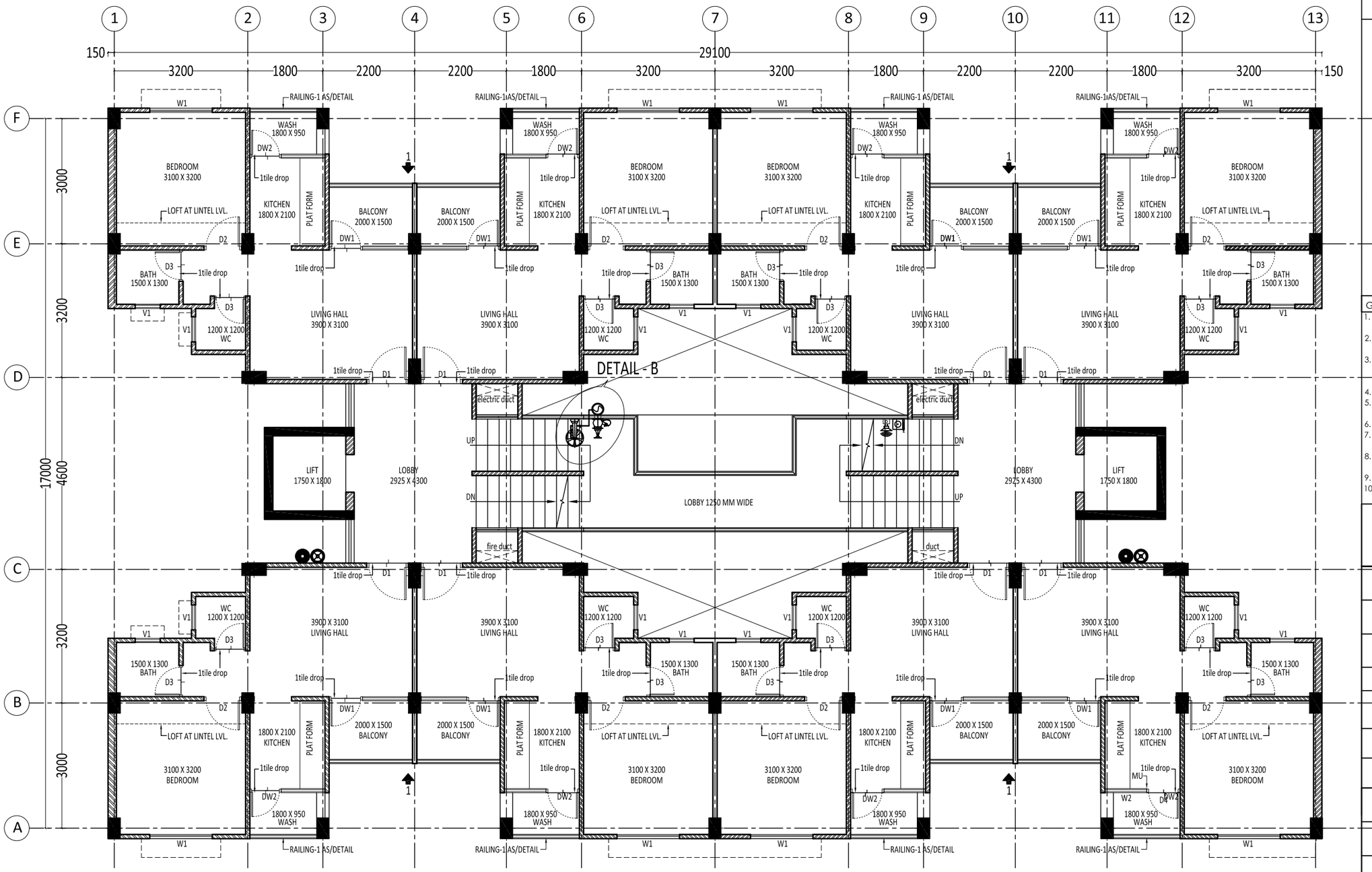
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SCALE	NTS	DRAWN BY		FF-01
GRID	-	PROJ. NO		

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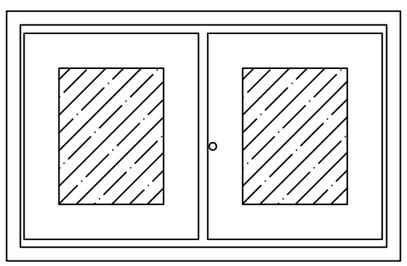
TYPICAL (1ST,3rd,5th&7th) FLOOR PLAN

GENERAL NOTES

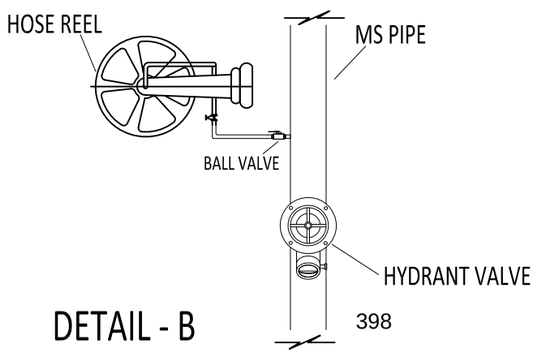
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9. PERIPHERAL PLINTH PROTECTION AS / TENDER ITEM.
10. ALL DIM. ARE IN MM.

LEGEND

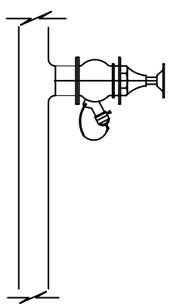
	MANUAL CALL POINT
	HOOTER
	HOSE REEL
	M.S. HYDRANT PIPE
	SINGLE HEADED HYDRANT VALVE
	BUTTER FLY VALVE
	CO2 TYPE FIRE EXT
	ABC STORED PRESUURE FE
	MECHANICAL FOAM TYPE FE
	WATER CO2 TYPE FIRE EXT
	2-WAY FIRE BRIDGE CONNECTION



HOSE BOX DETAIL



DETAIL - B



HYDRANT DETAIL

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

DRAWING: TYPICAL (1ST,3rd,5th&7th) FLOOR FIRE PLAN (KANADIYA EXTENSION)

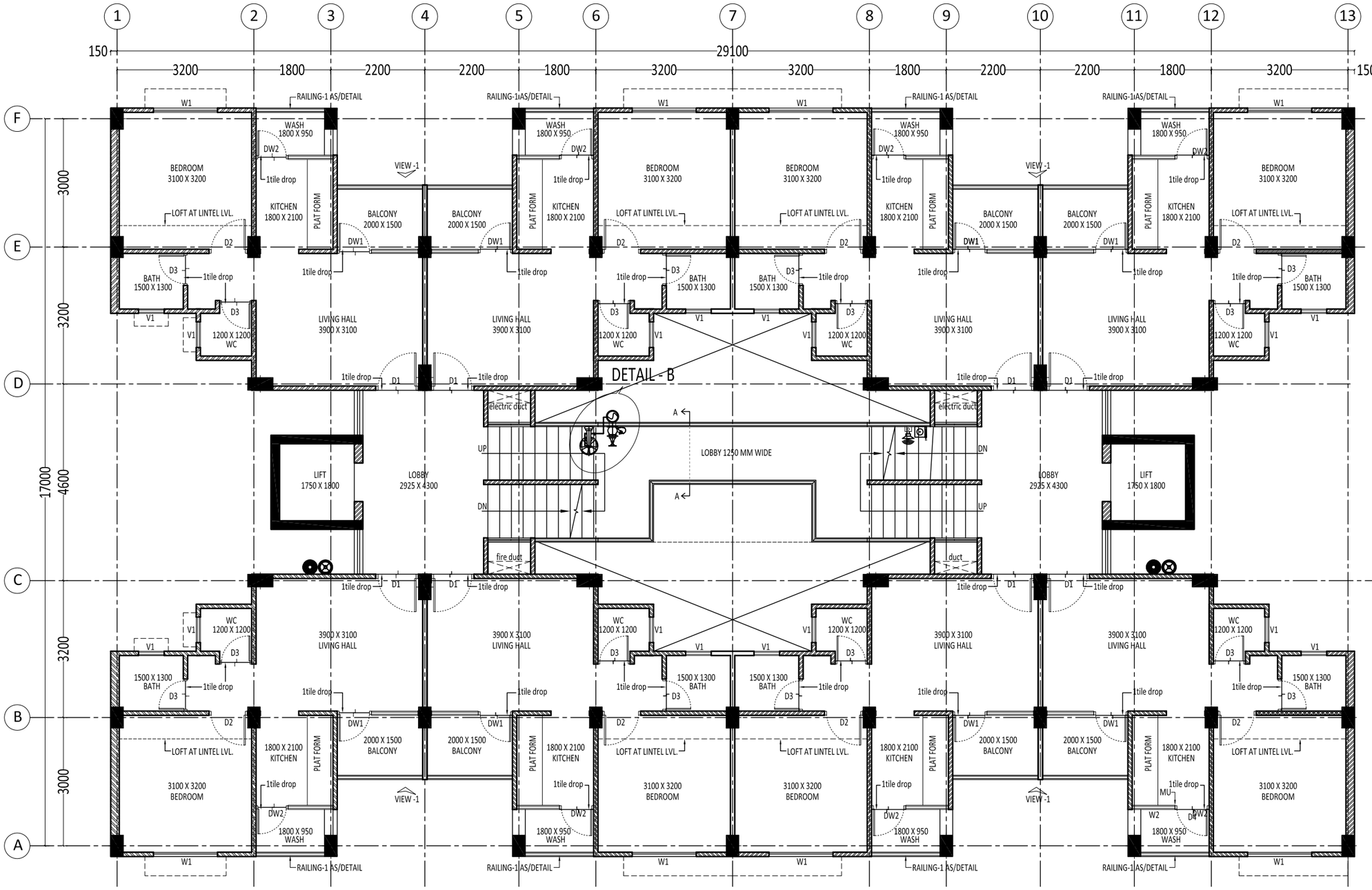
DATE	-	CHECKED BY		DRG. NO.
SCALE	NTS	DRAWN BY		FF-02
GRID	-	PROJ. NO		

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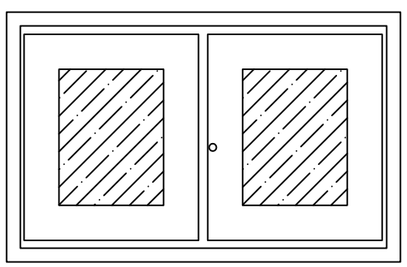
TYPICAL (2nd, 4th, 6th&8th) FLOOR PLAN

GENERAL NOTES

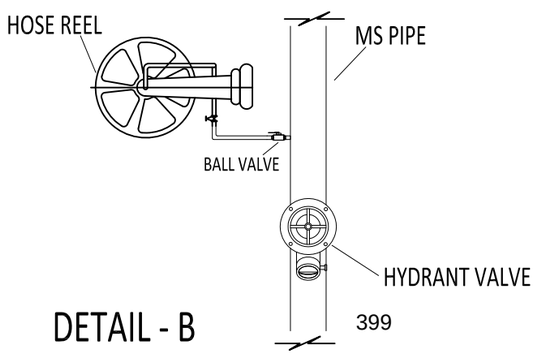
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7. ALL JUNCTIONS BETWEEN CONCRETE AND ANY OTHER MATERIAL TO BE PLASTERED ONLY AFTER FIXING CHICKEN MESH.
8. EMBEDDED PLATE SHALL BE PROVIDED AT LINTEL LVL. WHERE DOOR / WINDOW IS ADJOINING TO COLUMN.
9. PERIPHERAL PLINTH PROTECTION AS / TENDER ITEM.
10. ALL DIM. ARE IN MM.

LEGEND

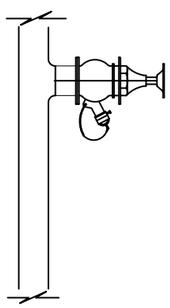
	MANUAL CALL POINT
	HOOTER
	HOSE REEL
	M.S. HYDRANT PIPE
	SINGLE HEADED HYDRANT VALVE
	BUTTER FLY VALVE
	CO2 TYPE FIRE EXT
	ABC STORED PRESUURE FE
	MECHANICAL FOAM TYPE FE
	WATER CO2 TYPE FIRE EXT
	2-WAY FIRE BRIDGE CONNECTION



HOSE BOX DETAIL



DETAIL - B



HYDRANT DETAIL

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

DRAWING: TYPICAL (2nd, 4th, 6th&8th) FLOOR FIRE PLAN (KANADIYA EXTENSION)

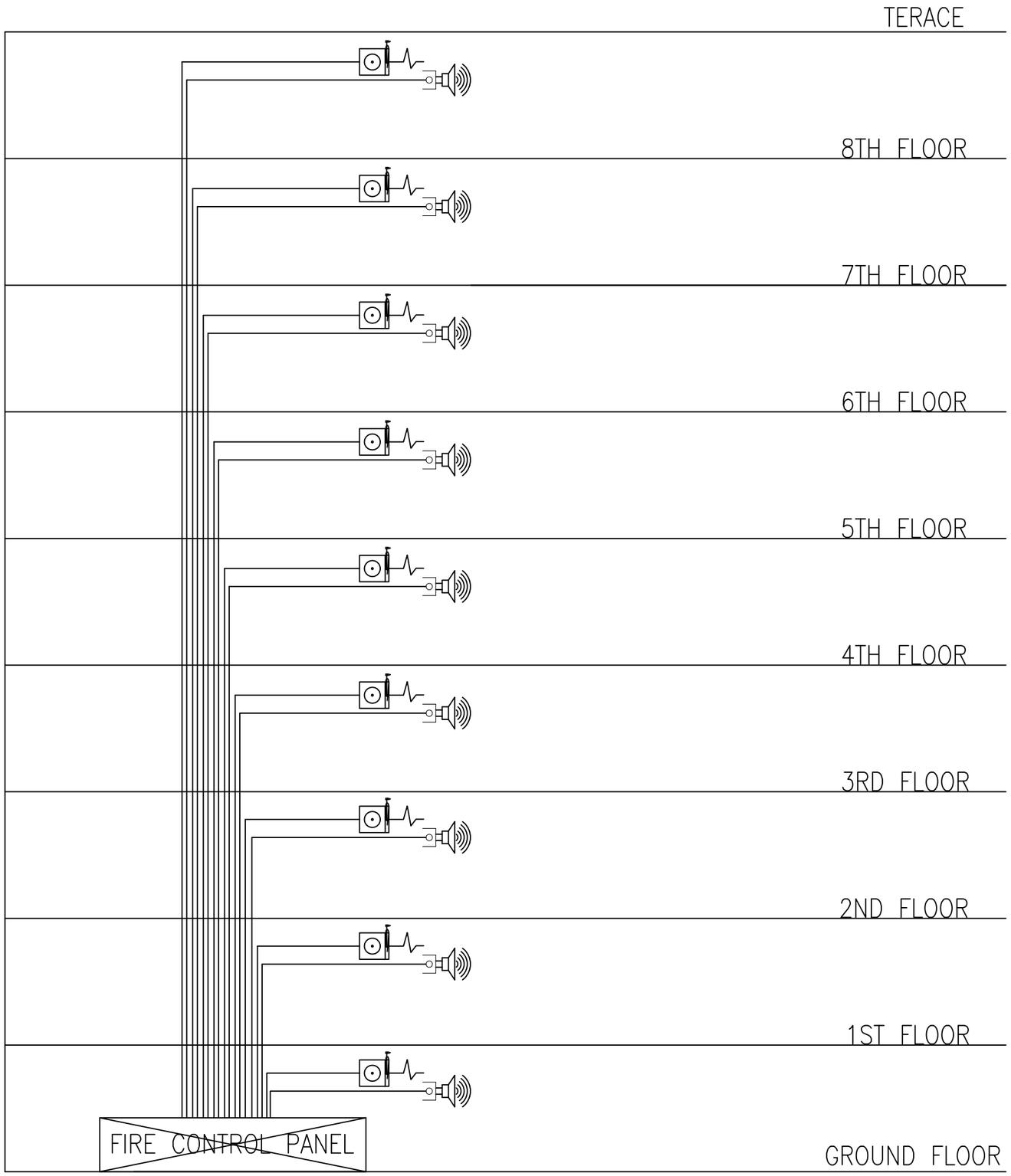
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GRID	-	PROJ. NO		

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TYPICAL FIRE ALARM SECTION

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9. PERIPHERAL PLINTH PROTECTION AS / TENDER ITEM.
10. ALL DIM. ARE IN MM.

LEGEND

	MANUAL CALL POINT
	HOOTER
	HOSE REEL
	M.S. HYDRANT PIPE
	SINGLE HEADED HYDRANT VALVE
	BUTTER FLY VALVE
	CO2 TYPE FIRE EXT
	ABC STORED PRESUURE FE
	MECHANICAL FOAM TYPE FE
	WATER CO2 TYPE FIRE EXT
	2-WAY FIRE BRIDGE CONNECTION

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

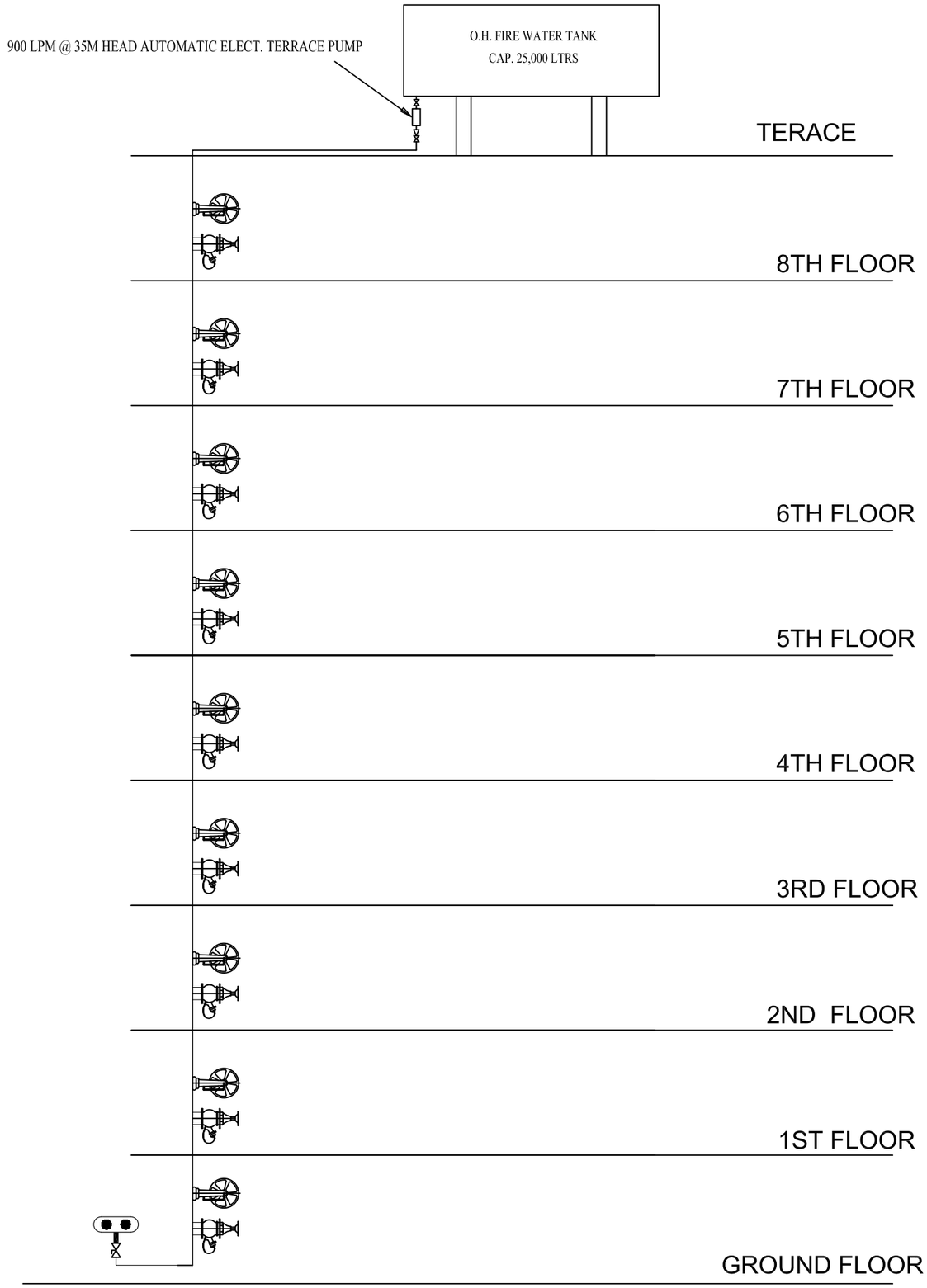
DRAWING: FIRE ALARM SECTION DETAIL - EWS BLOCK (KANADIYA EXTENSION)

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SCALE	NTS	DRAWN BY		FF-06
GRID	-	PROJ. NO		

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TYPICAL FIRE FIGHTING HYDRANT SYSTEM SECTION

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9. PERIPHERAL PLINTH PROTECTION AS / TENDER ITEM.
10. ALL DIM. ARE IN MM.

LEGEND

	MANUAL CALL POINT
	HOOTER
	HOSE REEL
	M.S. HYDRANT PIPE
	SINGLE HEADED HYDRANT VALVE
	BUTTER FLY VALVE
	CO2 TYPE FIRE EXT
	ABC STORED PRESUURE FE
	MECHANICAL FOAM TYPE FE
	WATER CO2 TYPE FIRE EXT
	2-WAY FIRE BRIDGE CONNECTION

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

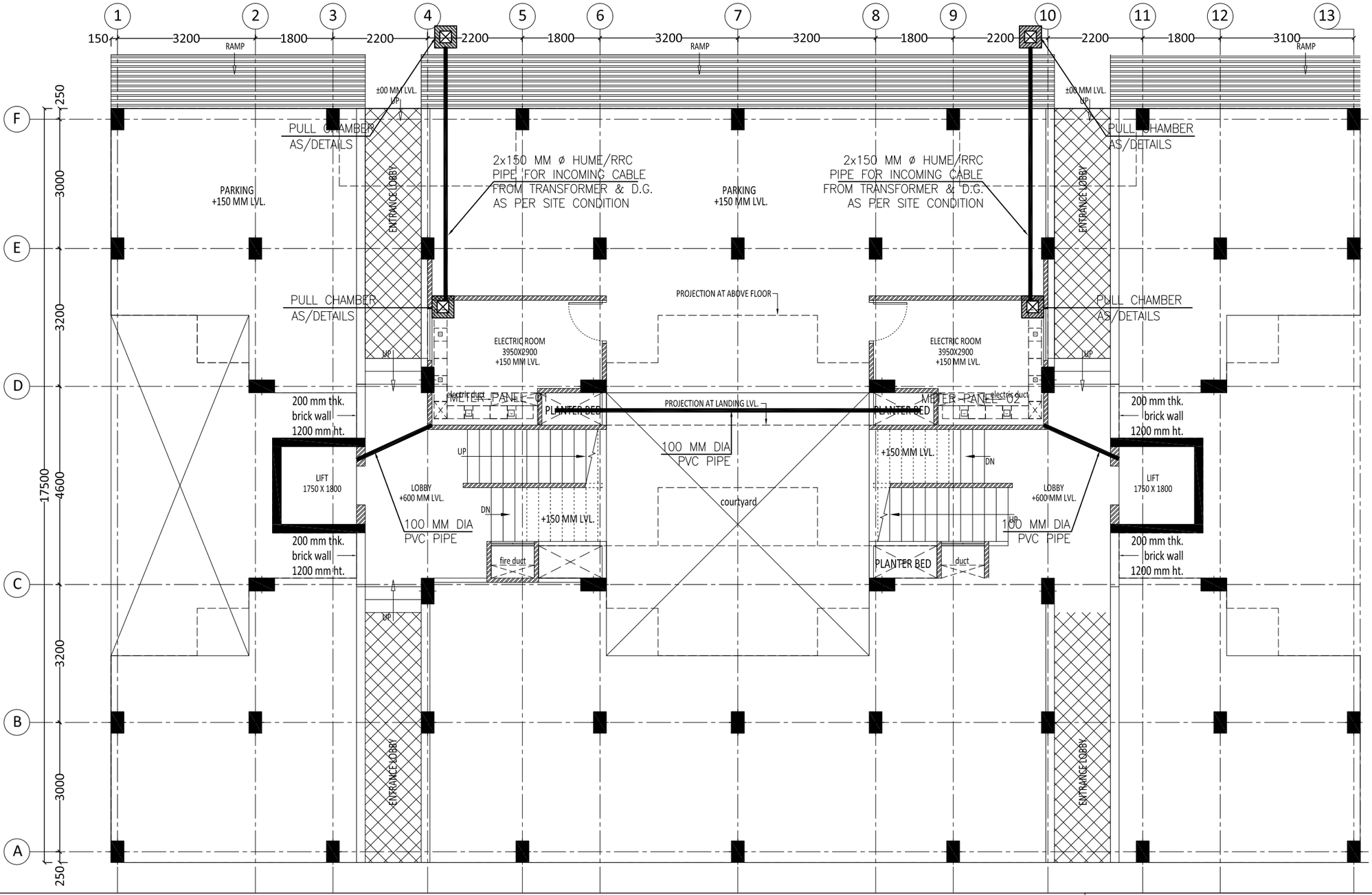
DRAWING: HYDRANT SECTION DETAIL - EWS BLOCK (KANADIYA EXTENSION)

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SCALE	NTS	DRAWN BY		**FF-05**
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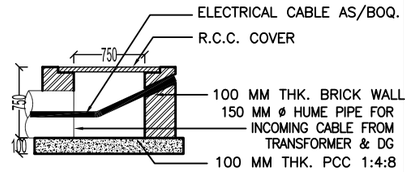
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STILT FLOOR PLAN



PULL CHAMBER FOR ELECTRIC CABLE
SIZE–750MMX750MMX750MM



TYP. SECTION OF PULL CHAMBER FOR ELECTRIC
CABLE SIZE–750MMX750MMX750MM

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA
MANPUR SITE (PMAY), INDORE

CLIENT :
INDORE MUNICIPAL CORPORATION

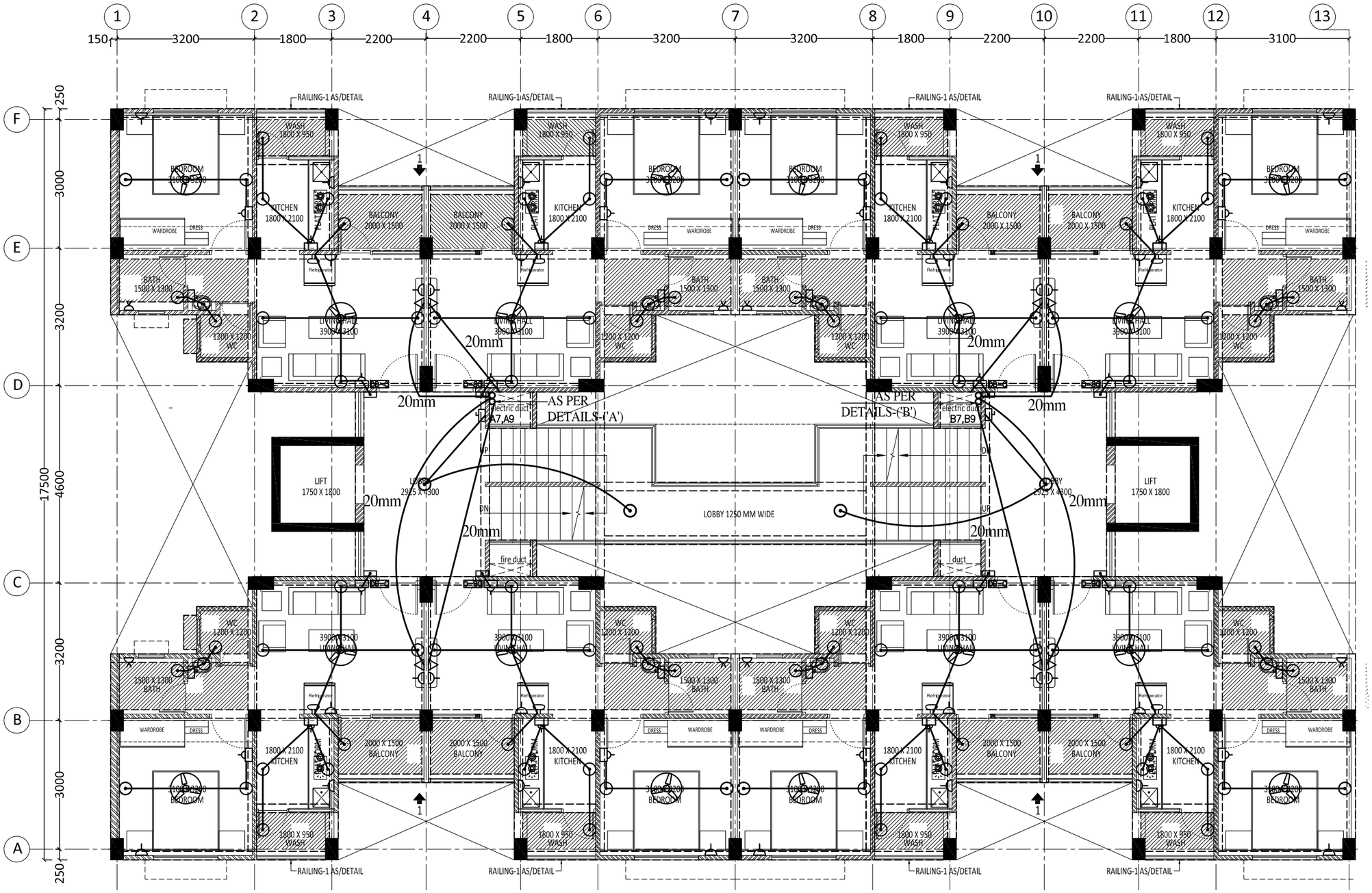
DRAWING: SLEEVE DETAIL FOR ELECTRICAL CABLE AT STILT FLOOR
(PARKING) - EWS BLOCK (KANADIYA EXTENSION)

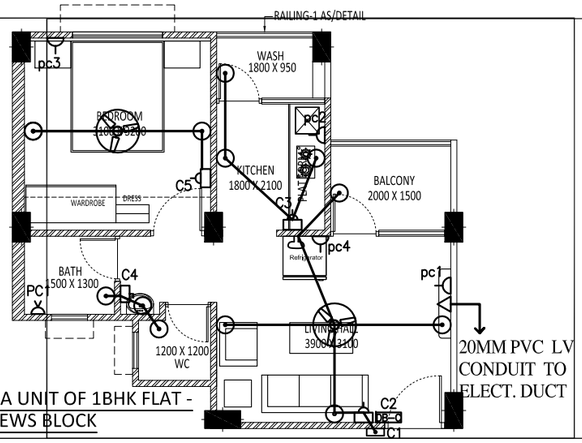
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A UNIT OF 1BHK FLAT - EWS BLOCK

TYPICAL (1st, 3rd, 5th & 7th) FLOOR PLAN

MOUNTING HEIGHTS

SL.NO	DESCRIPTION	HEIGHT FROM FINISHED FLOOR LEVEL (Reference to bottom)
1	SB DISTANCE FROM EDGE OF WALL NEAR DOOR	150MM
2	POINT FOR EXHAUST FAN	2400MM
3	TOILET SWITCH BOARD	1200MM
4	GEYSER SOCKET	2100MM/AS PER SIDE CONDITION
5	GEYSER SOCKET CONTROL	1200MM/AS PER SIDE CONDITION
6	SOCKET FOR REFRIGERATOR	1200MM
7	SWITCHES & SOCKETS IN LIVING DINING & GENERAL AREAS	1200MM
8	CALL BELL SWITCH/VDP-OUTDOOR	1200MM
9	BUZZER/VDP-INDOOR	2100MM
10	ALL WALL LIGHT POINTS	2400MM
11	BOTTOM OF DB	2100MM/AS PER SIDE CONDITION
12	SOCKETS AND SWITCH BOARD FOR STUDY TABLE	900MM
13	TV OUTLET AND ANY OTHER SOCKETS IN THE BEDROOMS	900MM
14	TV AND SOCKETS IN LIVING AND DINING AREAS	1200MM
15	SOCKETS IN THE KITCHEN	300MM ABOVE KITCHEN PLATFORM

CAPACITY OF CONDUITS FOR WIRES

SIZE OF WIRES	MAXIMUM NUMBER OF WIRES		
DIA OF CONDUIT ▶	20MM/3/4"	25MM/1"	32MM/1-1/4"
C.S.A OF WIRES IN SQMM ▼			
1.5SQMM	5	10	18
2.5SQMM	5	8	12
4 SQMM	3	6	10
6 SQMM	2	4	5

NOTE :- GREEN COLOUR EARTH WIRE 2.5 SQMM CU WIRE FOR CIRCUIT WIRING AND 1 NOS CU. EARTH WIRE SAME SIZE OF SUB-MAIN SHALL RUN INSIDE THE SAME CONDUIT AND FOR 16/20 AMP SOKET OULET 4.0 SQMM CU. WIRE. SEPARATE CONDUIT SHALL BE USED FOR POINT, CIRCUIT AND SUB-MAIN WIRING.

DETAIL ('A') - 2 NOS. 25 MM PVC CONDUIT FROM DB-A TO 3RD FLOOR AND 1 NOS. 25 MM PVC CONDUIT FROM 3RD TO 6TH FLOOR & TERRACE PLAN

DETAIL ('B') - 2 NOS. 25 MM PVC CONDUIT FROM DB-B TO 3RD FLOOR AND 1 NOS. 25 MM PVC CONDUIT FROM 3RD TO 6TH FLOOR & TERRACE PLAN

NOTE :- COMMON AREA LIGHTING POINT/FIXTURE OPERATE IN ALTERNATELY GROUP CONTROL

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA MANPUR SITE (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

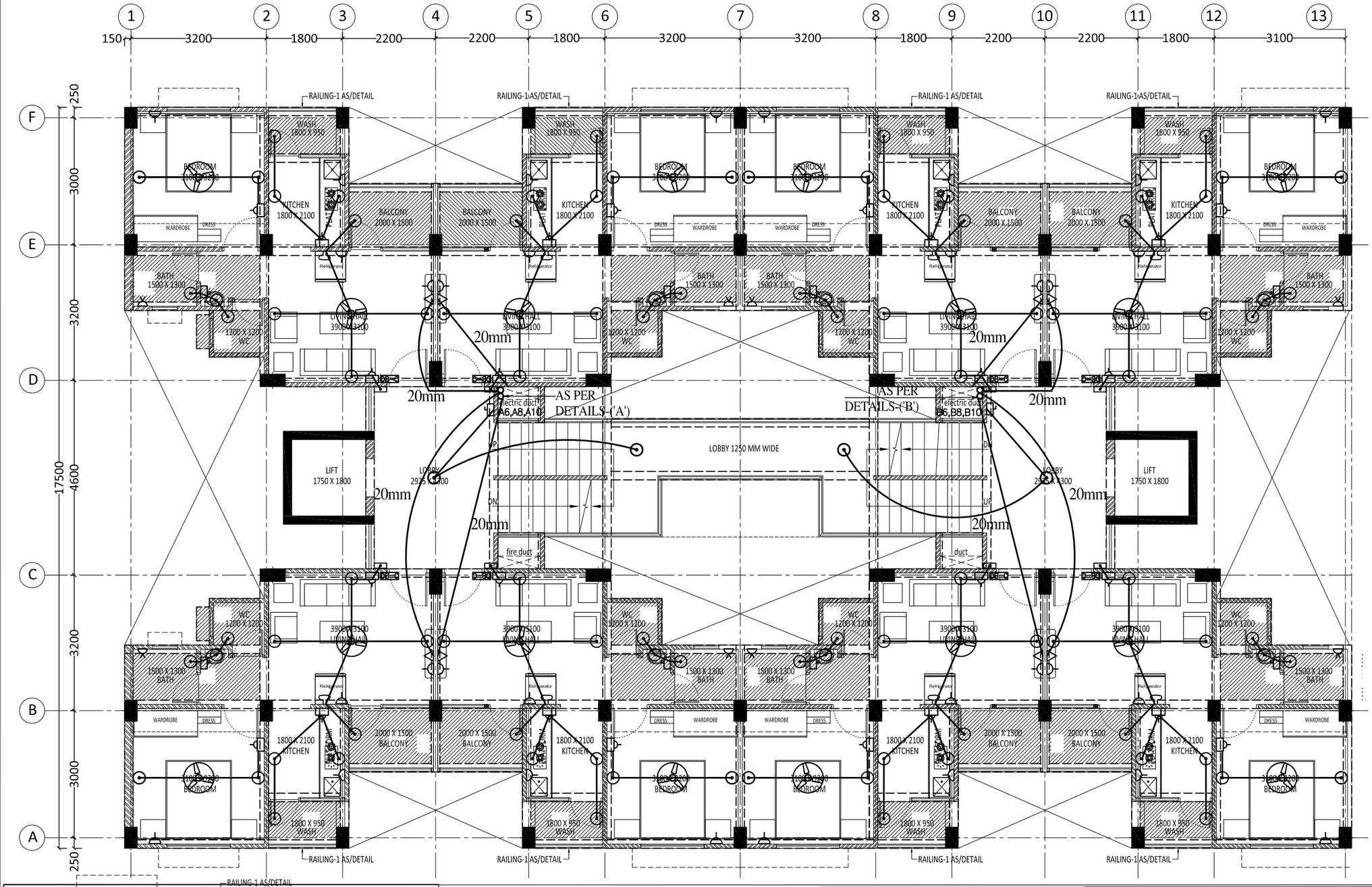
DRAWING: ELECTRICAL POINT & CONDUIT LAYOUT PLAN OF TYPICAL (1ST, 3rd,5th & 7th) FLOOR PLAN EWS BLOCK (KANADIYA EXTENSION)

DATE		CHECKED BY		DRG. NO.
SCALE	1:100	DRAWN BY		E-02
GRID	-	PROJ. NO		

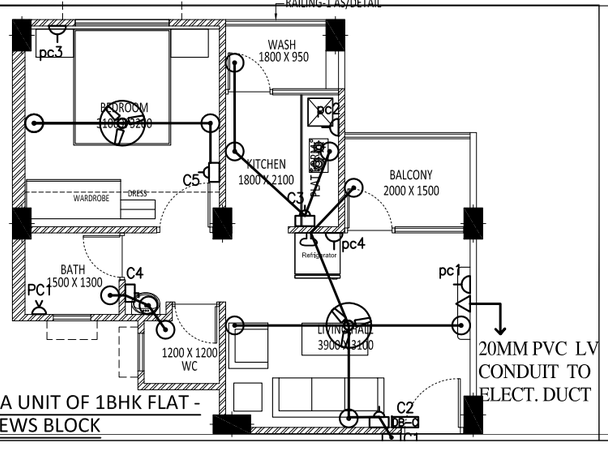
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LEGEND	
SYMBOL	PARTICULAR
	CEILLING FAN
	SWITCH BOARD
	SWITCH BOARD WITH 6A SOCKET OUTLET
	6A SOCKET OUTLET
	16A SOCKET OUTLET
	TV POINT
DB	DISTRIBUTION BOARD
	BELL PUSH
	BELL
PB	PULL BOX
JB	JUNCTION BOX
	CIRCUIT CONDUIT
	POWER CONDUIT
	SUB-MAIN CONDUIT
	LV CONDUIT



A UNIT OF 1BHK FLAT - EWS BLOCK

TYPICAL (2nd, 4th, 6th & 8th) FLOOR PLAN

MOUNTING HEIGHTS

SL.NO	DESCRIPTION	HEIGHT FROM FINISHED FLOOR LEVEL (Reference to bottom)
1	SB DISTANCE FROM EDGE OF WALL NEAR DOOR	150MM
2	POINT FOR EXHAUST FAN	2400MM
3	TOILET SWITCH BOARD	1200MM
4	GEYSER SOCKET	2100MM/AS PER SIDE CONDITION
5	GEYSER SOCKET CONTROL	1200MM/AS PER SIDE CONDITION
6	SOCKET FOR REFRIGERATOR	1200MM
7	SWITCHES & SOCKETS IN LIVING DINING & GENERAL AREAS	1200MM
8	CALL BELL SWITCH/VDP-OUTDOOR	1200MM
9	BUZZER/VDP-INDOOR	2100MM
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11	BOTTOM OF DB	2100MM/AS PER SIDE CONDITION
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CAPACITY OF CONDUITS FOR WIRES

SIZE OF WIRES	MAXIMUM NUMBER OF WIRES		
DIA OF CONDUIT ▶	20MM/3/4"	25MM/1"	32MM/1-1/4"
C.S.A OF WIRES IN SQMM ▼			
1.5SQMM	5	10	18
2.5SQMM	5	8	12
4 SQMM	3	6	10
6 SQMM	2	4	5

NOTE :- GREEN COLOUR EARTH WIRE 2.5 SQMM CU WIRE FOR CIRCUIT WIRING AND 1 NOS CU. EARTH WIRE SAME SIZE OF SUB-MAIN SHALL RUN INSIDE THE SAME CONDUIT AND FOR 16/20 AMP SOKET OULET 4.0 SQMM CU. WIRE. SEPARATE CONDUIT SHALL BE USED FOR POINT, CIRCUIT AND SUB-MAIN WIRING.

DETAIL ('A') - 2 NOS. 25 MM PVC CONDUIT FROM DB-A TO 3RD FLOOR AND 1 NOS. 25 MM PVC CONDUIT FROM 3RD TO 6TH FLOOR & TERRACE PLAN

DETAIL ('B') - 2 NOS. 25 MM PVC CONDUIT FROM DB-B TO 3RD FLOOR AND 1 NOS. 25 MM PVC CONDUIT FROM 3RD TO 6TH FLOOR & TERRACE PLAN

NOTE :- COMMON AREA LIGHTING POINT/FIXTURE OPERATE IN ALTERNATELY GROUP CONTROL

PROJECT: HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA MANPUR SITE (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

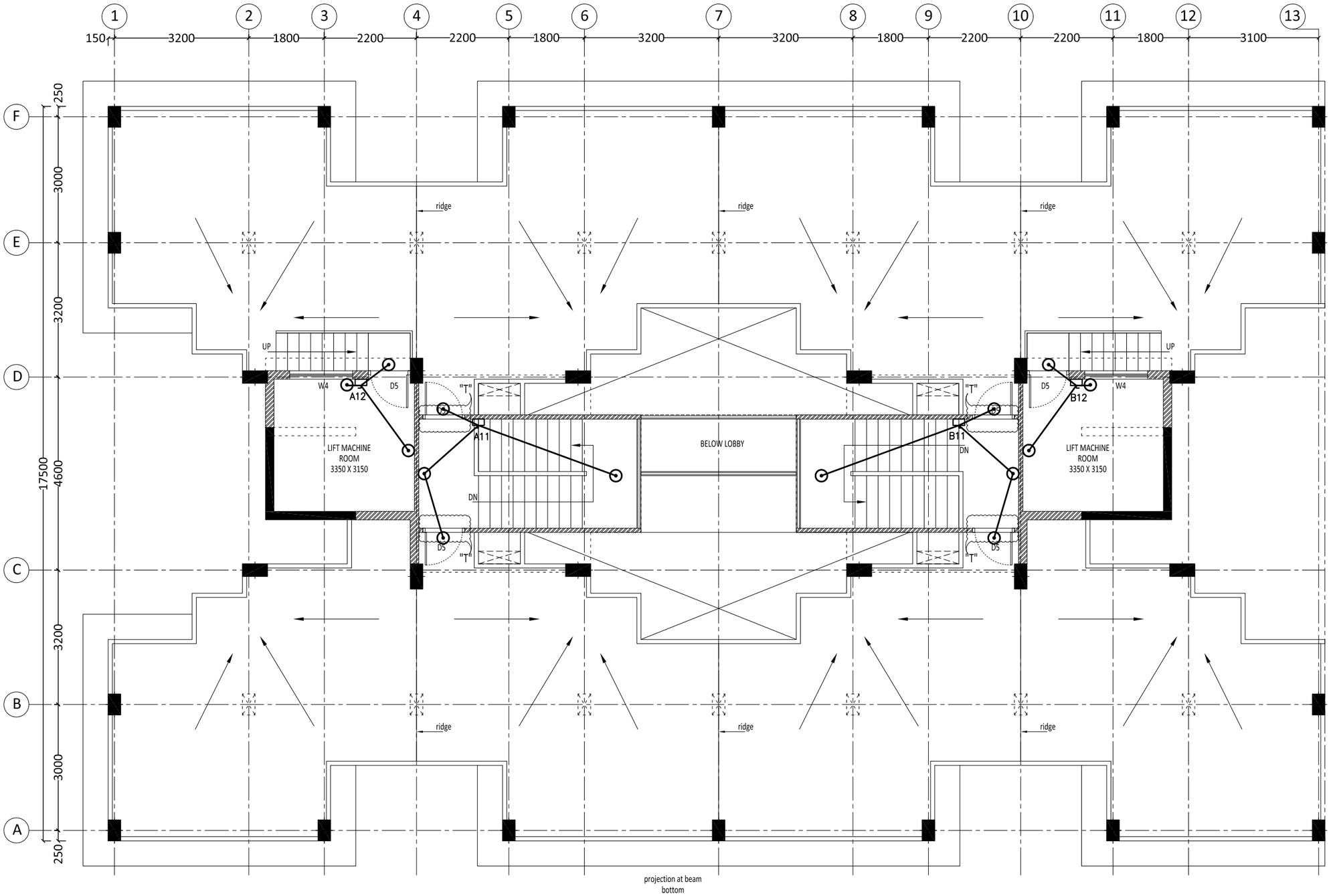
DRAWING: ELECTRICAL POINT & CONDUIT LAYOUT PLAN OF TYPICAL (2nd,4th,6th& 8th) FLOOR PLAN EWS BLOCK (KANADIYA EXTENSION)

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LEGEND	
SYMBOL	PARTICULAR
	CEILLING FAN
	SWITCH BOARD
	SWITCH BOARD WITH 6A PLUG
	LIGHT POINT
	POINT CONDUIT

CAPACITY OF CONDUITS FOR WIRES

SIZE OF WIRES	MAXIMUM NUMBER OF WIRES		
DIA OF CONDUIT ▶	20MM/3/4"	25MM/1"	32MM/1-1/4"
C.S.A OF WIRES IN SQMM ▼			
1.5SQMM	5	10	18
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6SQMM	2	4	5

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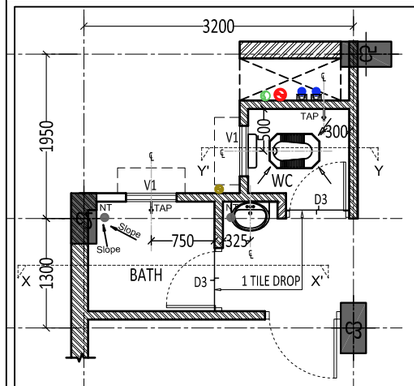
DRAWING: ELECTRICAL POINT & CONDUIT LAYOUT PLAN OF TERRACE PLAN - EWS BLOCK(KANADIYA EXTENSION)

DATE		CHECKED BY		DRG. NO.
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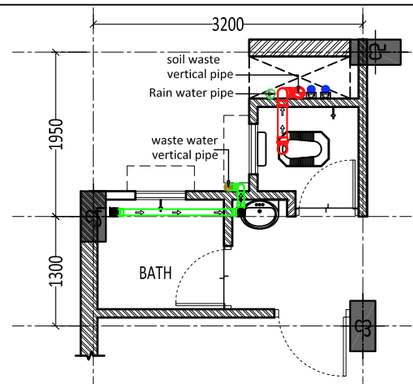
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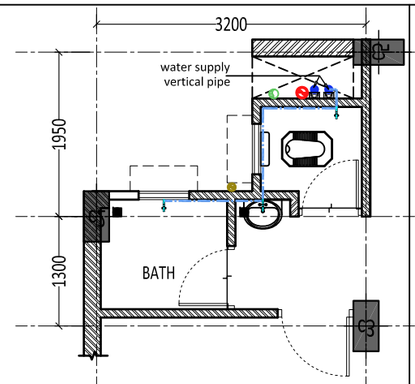
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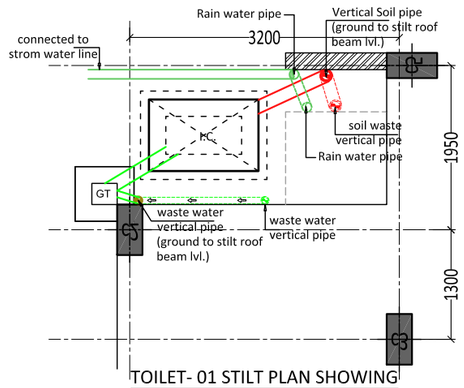
TOILET- 01 TYPICAL PLAN SHOWING
SANITARY FIXTURES & FITTINGS
(1ST TO 8TH FLOOR)



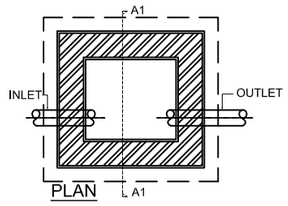
TOILET- 01 TYPICAL PLAN SHOWING
DRAINAGE LAYOUT
(1ST TO 8TH FLOOR)



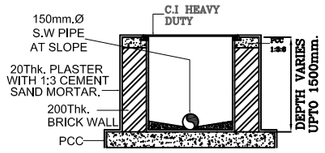
TOILET- 01 TYPICAL PLAN SHOWING
WATER SUPPLY LAYOUT
(1ST TO 8TH FLOOR)



TOILET- 01 STILT PLAN SHOWING
DRAINAGE LAYOUT

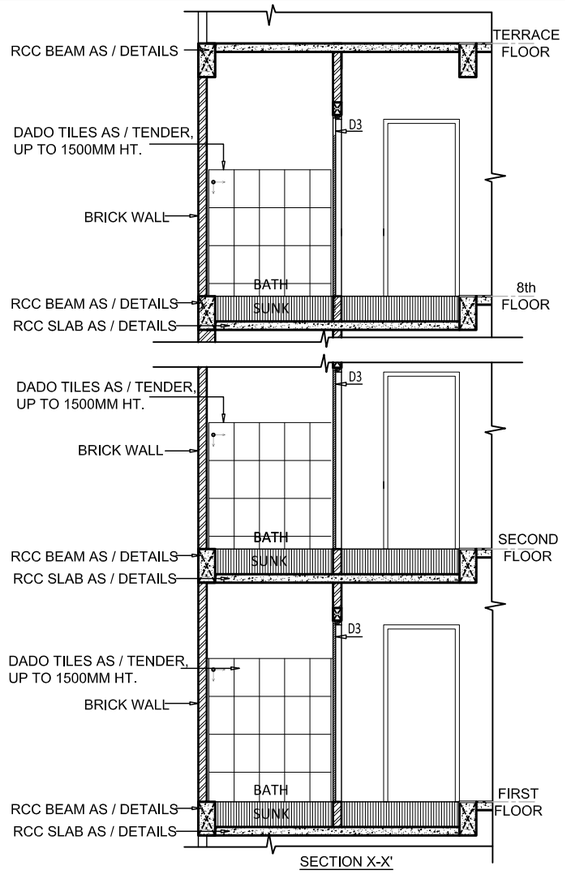


PLAN

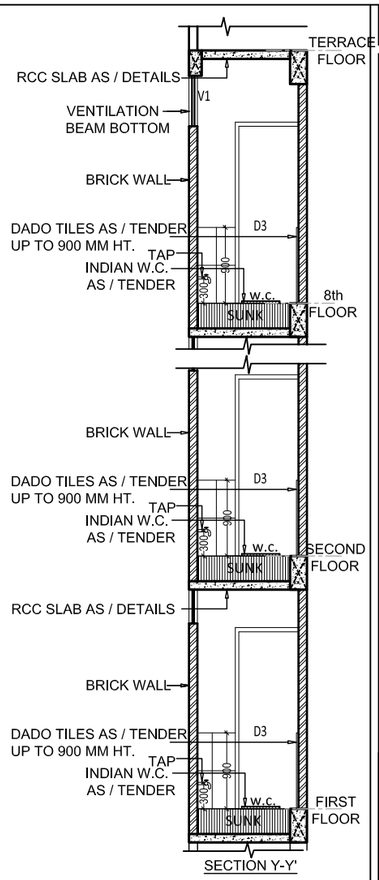


SECTION A1-A1

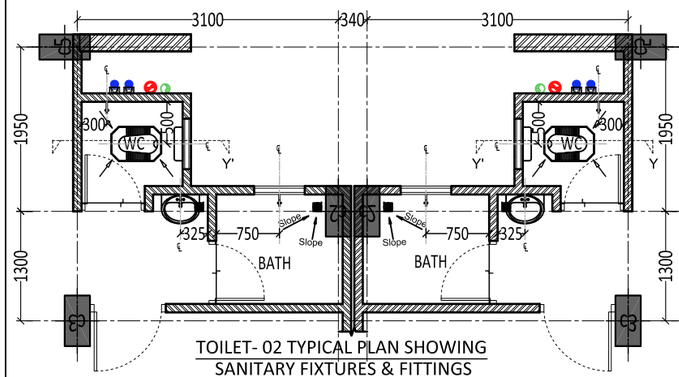
INSPECTION CHAMBER



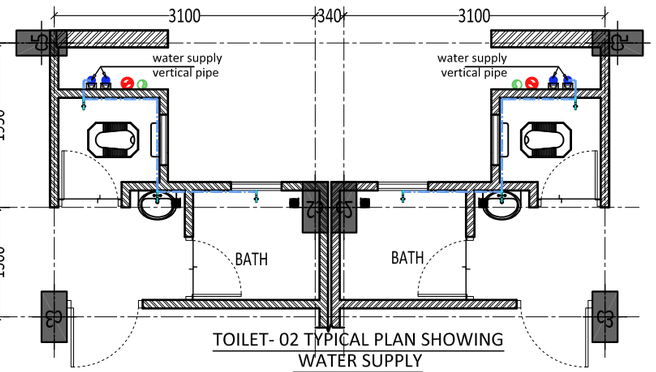
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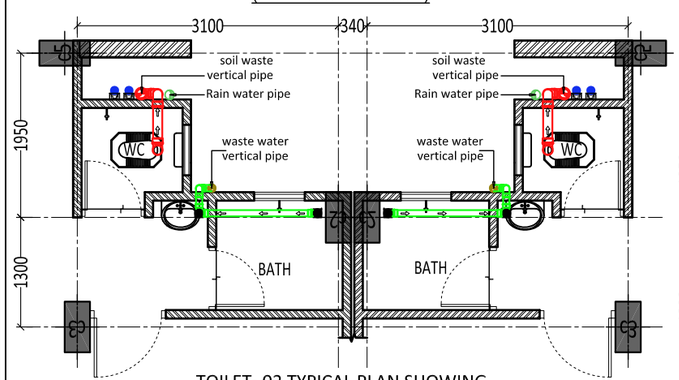
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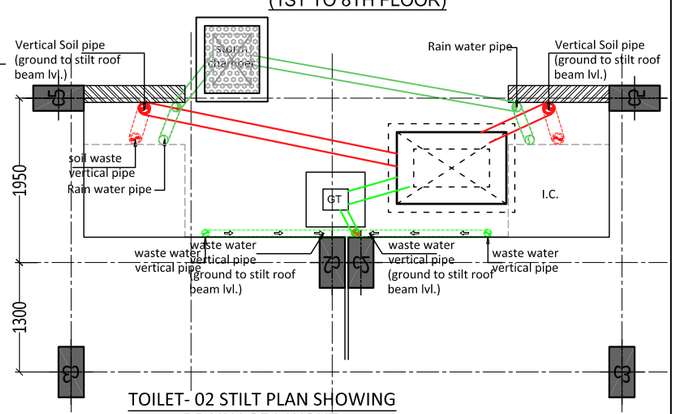
TOILET- 02 TYPICAL PLAN SHOWING
SANITARY FIXTURES & FITTINGS
(1ST TO 8TH FLOOR)



TOILET- 02 TYPICAL PLAN SHOWING
WATER SUPPLY
(1ST TO 8TH FLOOR)

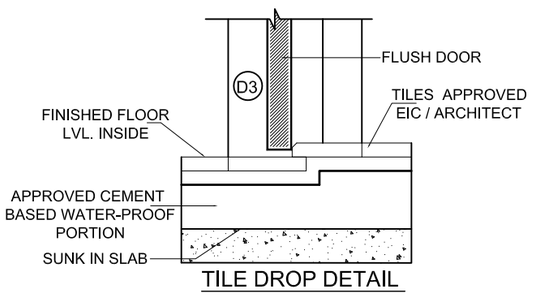


TOILET- 02 TYPICAL PLAN SHOWING
DRAINAGE LAYOUT
(1ST TO 8TH FLOOR)

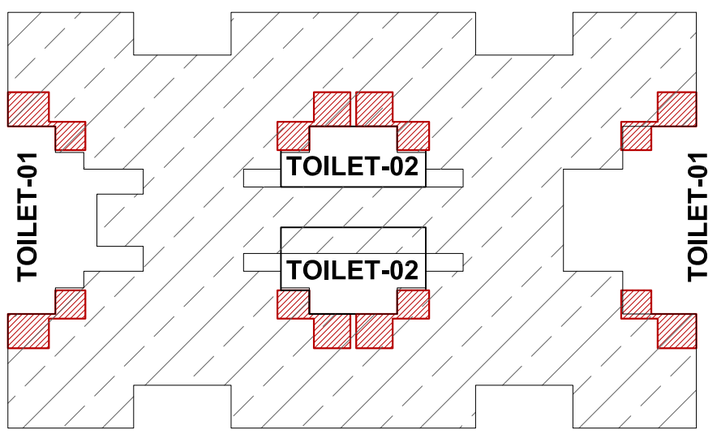


TOILET- 02 STILT PLAN SHOWING
DRAINAGE LAYOUT

406



TILE DROP DETAIL



KEY PLAN:-

TYPICAL (1st TO 8th) FLOOR PLAN

GENERAL NOTES

1. THE CONTRACTOR/ DEPARTMENT SHOULD CONFIRM THE PLOT BOUNDARY/ STATUTORY CLEARANCES PRIOR TO COMMENCEMENT OF EXECUTION ANY AMBIGUITY SHOULD BE BROUGHT TO NOTICE OF CONSULTANT PRIOR TO EXECUTION OF THE WORK.
2. THE CONTRACTOR SHOULD ENSURE PROPER SAFETY PRECAUTION OF STRUCTURAL STABILITY OF EXISTING BUILDINGS , SAFETY OF SITE WORKERS AND ULB/GOVT. INFRASTRUCTURES NEAR BY SITE. DURING EXCAVATION . THIS SHALL BE THE SOLE RESPONSIBILITY OF CONTRACTOR.
3. THE STRENGTH & STRUCTURAL STABILITY STURDILY OF SCAFFOLDING CENTERING SHUTTERING MATERIAL LIFTS SHALL BE ENSURED BY THE CONTRACTOR AND SHALL BE THE RESPONSIBILITY OF CONTRACTOR.
4. THE STRENGTH STABILITY OF EXISTING BUILDING CLOSED TO THE CONSTRUCTION SITE SHALL BE ENSURED BY THE CONTRACTOR BY MEANS PROPER SHORING.
5. PRIOR APPROVAL SHOULD BE TAKEN FROM COMPETENT AUTHORITIES PRIOR TO EXECUTION.
6. THE DRAWING IS PREPARED ON THE APPROVED CONCEPT BY DEPARTMENT ALL THE NECESSARY STATUARY / ADMINISTRATIVE APPROVALS SHOULD BE ENSURED PRIOR TO EXECUTION.

LEGEND

1.	110 MM ø SOIL PVC PIPE LINE	
2.	75 MM ø WASTE PVC PIPE LINE	
3.	DIRECTION OF FLOW	
4.	1 TILE DROP	
5.	STARTING POINT	
6.	40MM PIPE WATER SUPPLY LINE	
7.	25MM PIPE WATER SUPPLY LINE	
8.	15MM PIPE WATER SUPPLY LINE	
9.	NAHANI TRAP	
10.	FLUSH TANK	FT

PROJECT:
HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA MANPUR SITE (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

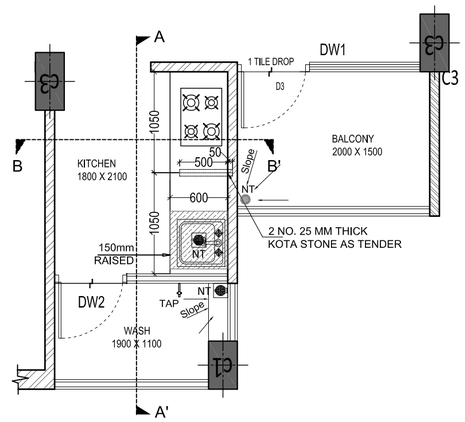
DRAWING: TOILET DETAIL - EWS BLOCK (KANADIYA EXTENSION)

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SCALE	-	DRAWN BY		AR-08
GRID	-	PROJ. NO		

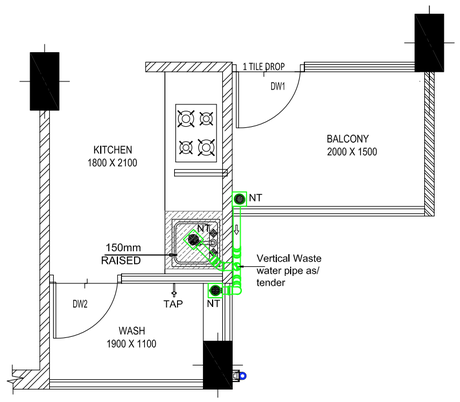
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ARCHITECT | NORTH

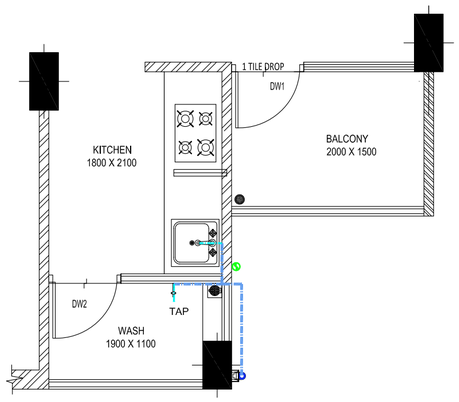
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Phone : 561124 ,4065064 Fax- (0731) 4065064
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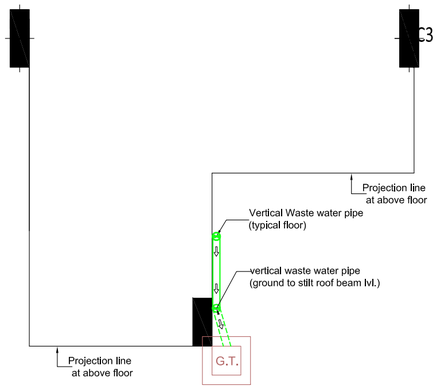
KITCHEN: TYPICAL PLAN SHOWING
FIXTURES & FITTINGS
(1ST TO 8TH FLOOR)



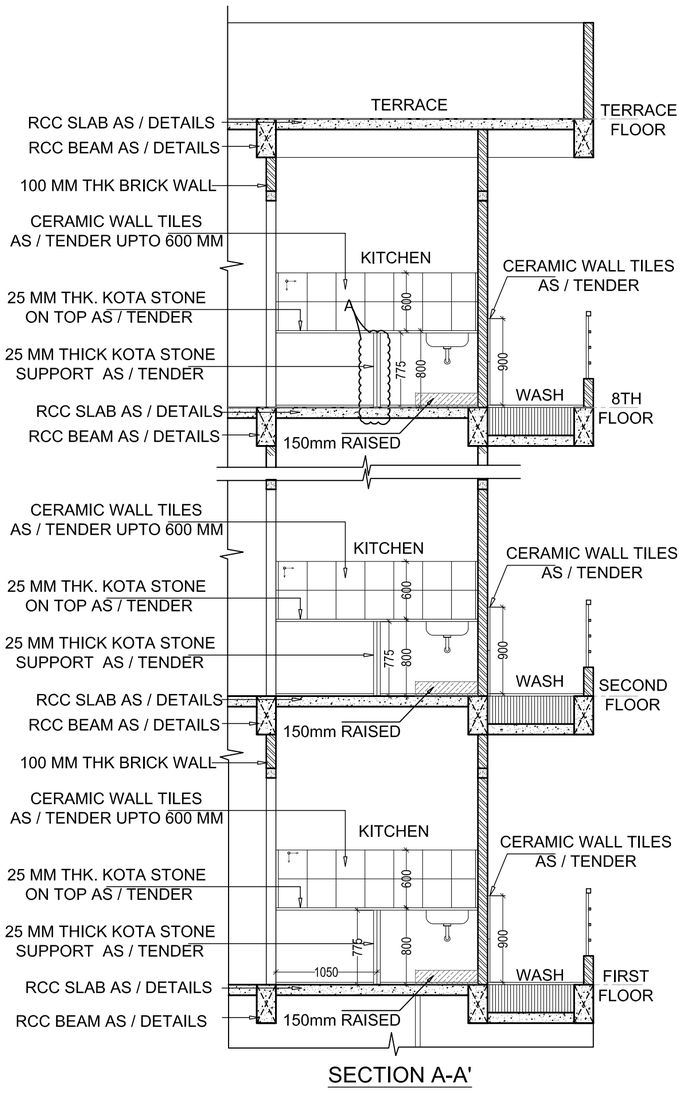
KITCHEN: TYPICAL PLAN SHOWING
DRAINAGE LAYOUT
(1ST TO 8TH FLOOR)



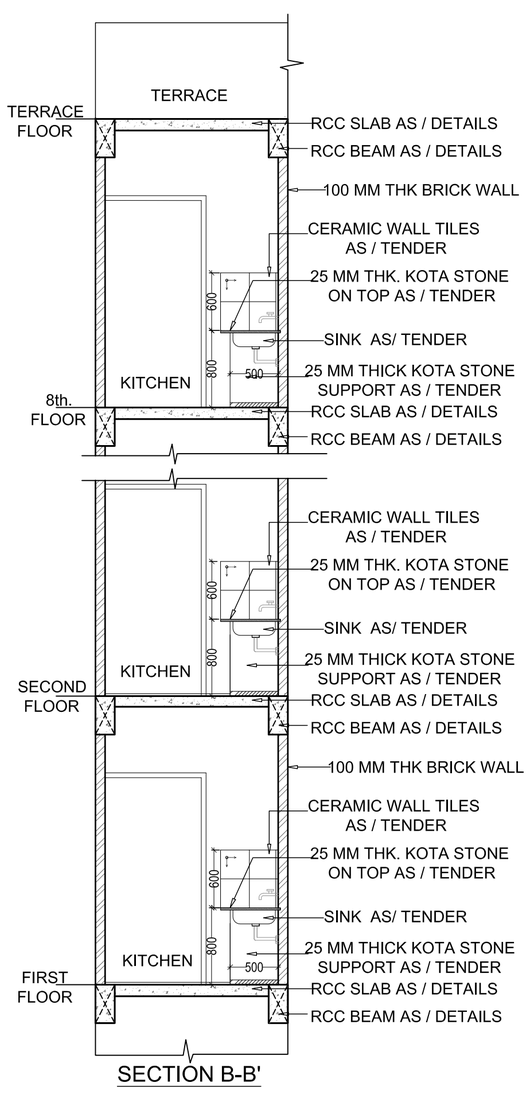
KITCHEN: TYPICAL PLAN SHOWING
WATER LAYOUT
(1ST TO 8TH FLOOR)



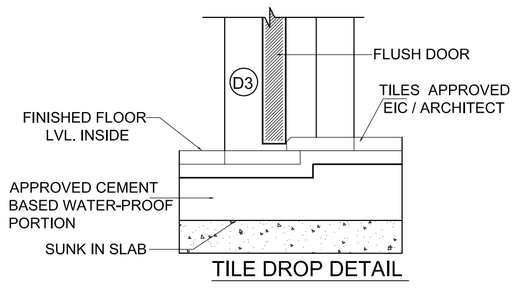
KITCHEN: STILT PLAN SHOWING
DRAINAGE LAYOUT



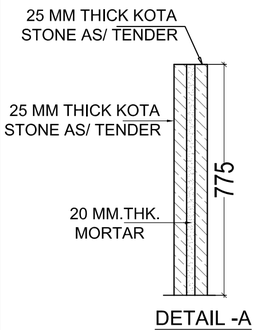
SECTION A-A'



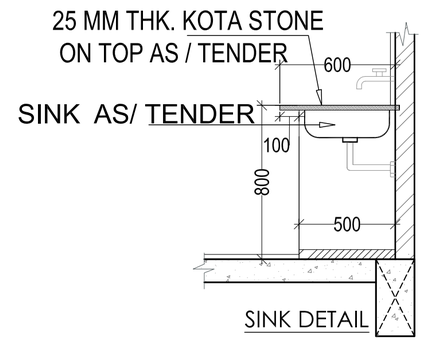
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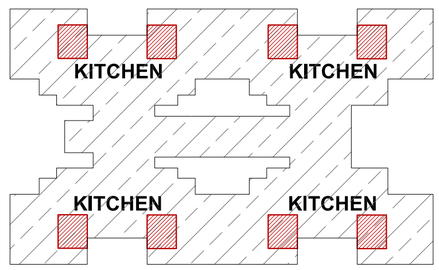
TILE DROP DETAIL



DETAIL -A



SINK DETAIL



KEY PLAN:-

TYPICAL FLOOR PLAN

AR-09

ONLY FOR TENDER PURPOSE

NOTE:

1). These are preliminary drawings giving broad ideas about the work.There can be certain modification as per final working drawing stage . It can be subjected to changes as required.

2). These drawing are general arrangement drawing and for TENDER purpose only these are STRICTLY NOT FOR CONSTRUCTION PURPOSE

*NOTE: ALL SANITARY FIXTURES, FLOORING, DADO AND ANY OTHER FINISHING ITEM SHOULD BE KEPT AS PER TENDER.

GENERAL NOTES

1. THE CONTRACTOR/ DEPARTMENT SHOULD CONFIRM THE PLOT BOUNDARY/ STATUTORY CLEARANCES PRIOR TO COMMENCEMENT OF EXECUTION ANY AMBIGUITY SHOULD BE BROUGHT TO NOTICE OF CONSULTANT PRIOR TO EXECUTION OF THE WORK.
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LEGEND

1.	75 MM Ø WASTE PVC PIPE LINE	
2.	NAHANI TRAP	
3.	DIRECTION OF FLOW	
4.	1 TILE DROP	
5.	STARTING POINT	
	WATER SUPPLY LINE	
6.	40MM PIPE WATER SUPPLY LINE	
7.	25MM PIPE WATER SUPPLY LINE	
8.	15MM PIPE WATER SUPPLY LINE	

PROJECT:

HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA MANPUR SITE (PMAY), INDORE

CLIENT : INDORE MUNICIPAL CORPORATION

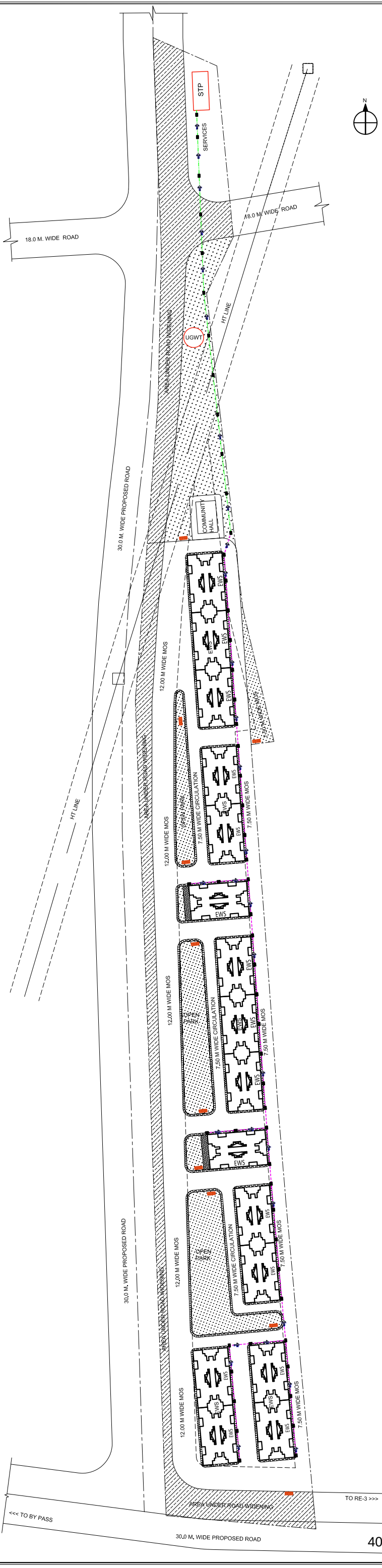
DRAWING: KITCHEN DETAIL - EWS BLOCK

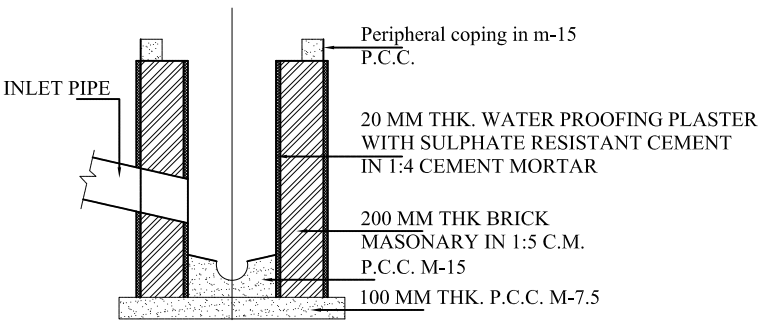
DATE	-	CHECKED BY		DRG. NO.
SCALE	-	DRAWN BY		AR-09
GRID	-	PROJ. NO		

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ARCHITECT | NORTH

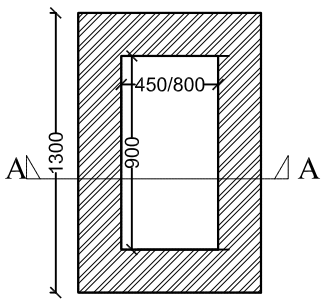
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ENGINEERS AND REGD. VALUERS
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Phone : 561124 ,4065064 Fax- (0731) 4065064
email : hitendramehta.architect@gmail.com





SECTION AT AA OF MAIN CHAMBER

NOTE:-
- d' depends as per site condition.
- d varies from 0.60 m. to 3.00 m.



PLAN MAIN
SEWER CHAMBER

LEGEND :

DUSTBIN

LEGEND:-

PARTICULAR	SYMBOL
SEWER CHAMBER	
SEWER LINE	
A. - 225 mm Ø RCC PIPE	
B. - 300 mm Ø RCC PIPE	

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

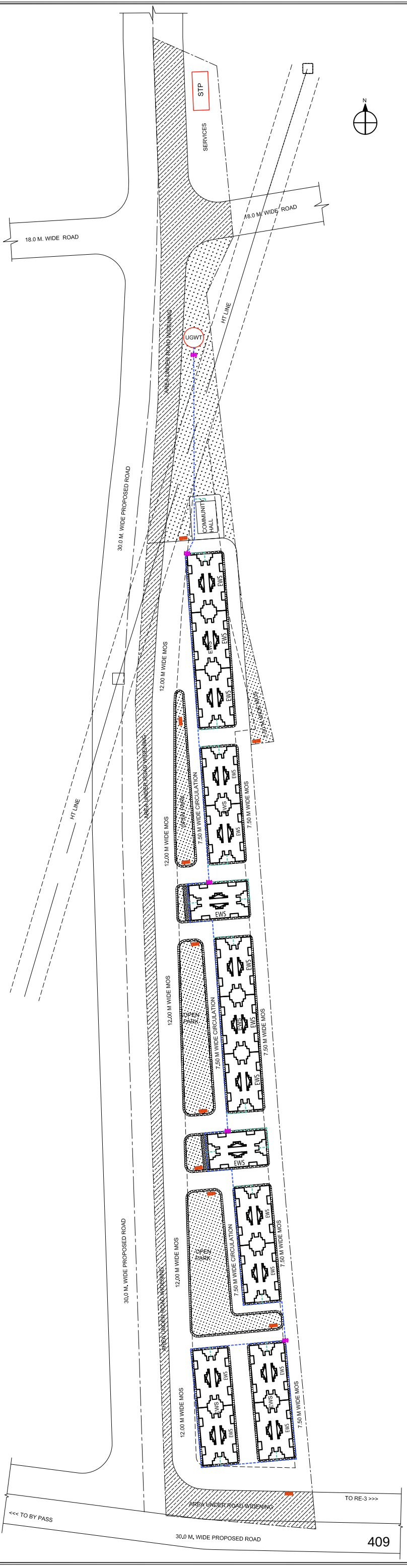
CLIENT - INDORE MUNICIPAL CORPORATION

DRAWING - SEWER LINE LAYOUT PLAN (KANADIYA EXTENSION)

DRG N0 - OD-02

SCALE - N.T.S.

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LEGEND :

DUSTBIN

LEGEND

S.NO.	PARTICULAR	SYMBOL
1.	WATER SUPPLY PIPE	
	A. 110 MM Ø PIPE	
	B. 50 MM Ø PIPE	
2.	SLUICE VALVE	
	WATER TRUNK LINE	

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

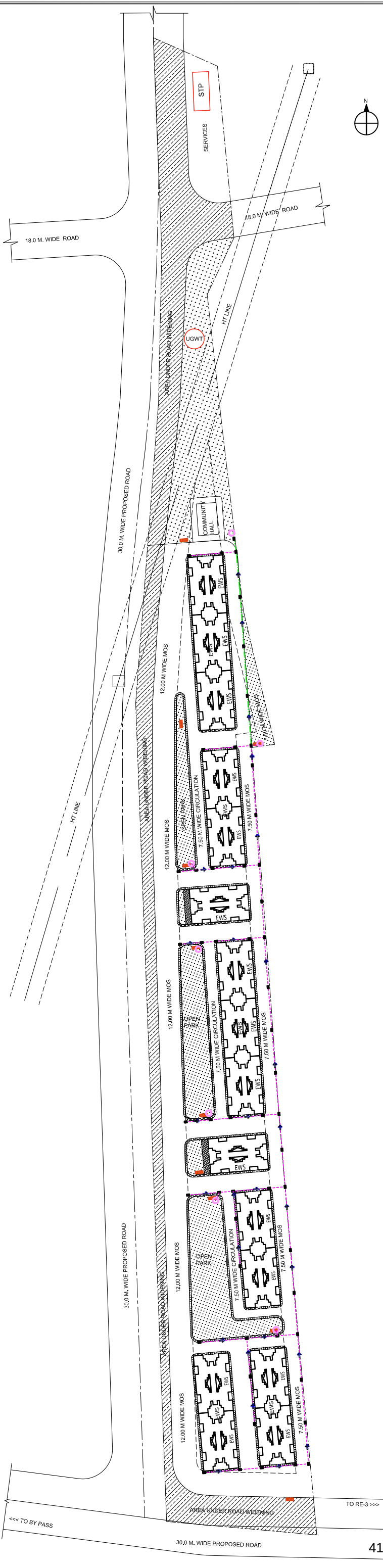
CLIENT - INDORE MUNICIPAL CORPORATION

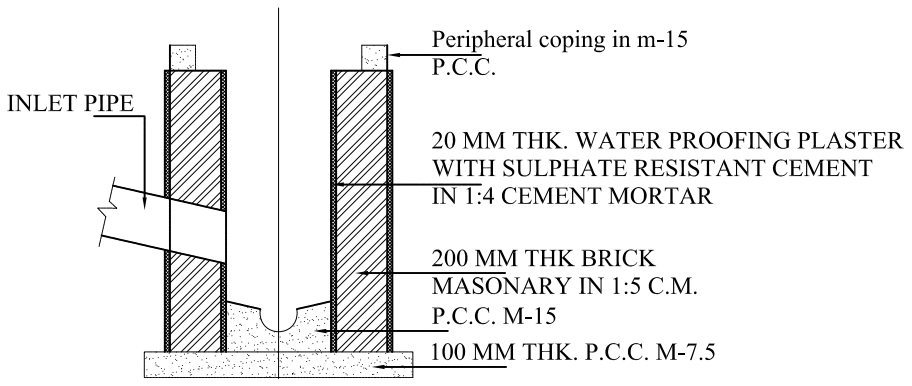
DRAWING - WATER LINE LAYOUT PLAN (KANADIYA EXTENSION)

DRG N0 - OD-04

SCALE - N.T.S.

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Email : hitendramehta.architect@gmail.com

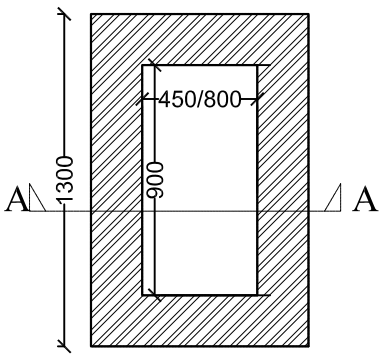




SECTION AT AA OF MAIN CHAMBER

NOTE:-

- d' depends as per site condition.
- d varies from 0.60 m. to 3.00 m.



PLAN MAIN
STORM CHAMBER

LEGEND :

DUSTBIN

LEGEND:-

S.NO.	Particular	Symbol
1.	STORM Chamber	
2.	STORM Line	
a.	225 mm Ø	
b.	300 mm Ø	
3.	OUT FALL POINT	
4.	WATER RECHARGE PIT	

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

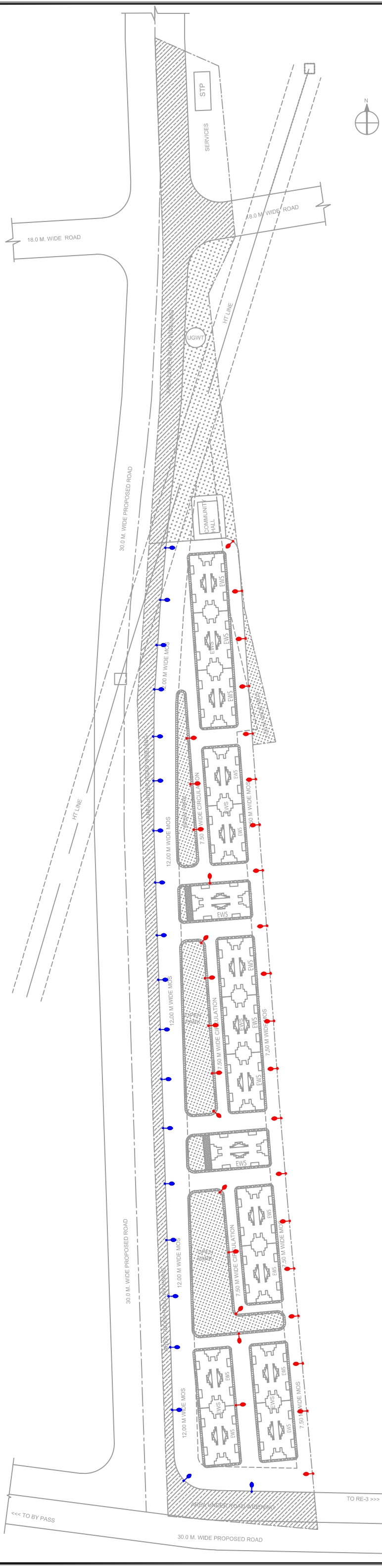
CLIENT - INDORE MUNICIPAL CORPORATION

DRAWING - STORM LINE LAYOUT PLAN (KANADIYA EXTENSION)

DRG N0 - OD-03

SCALE - N.T.S.

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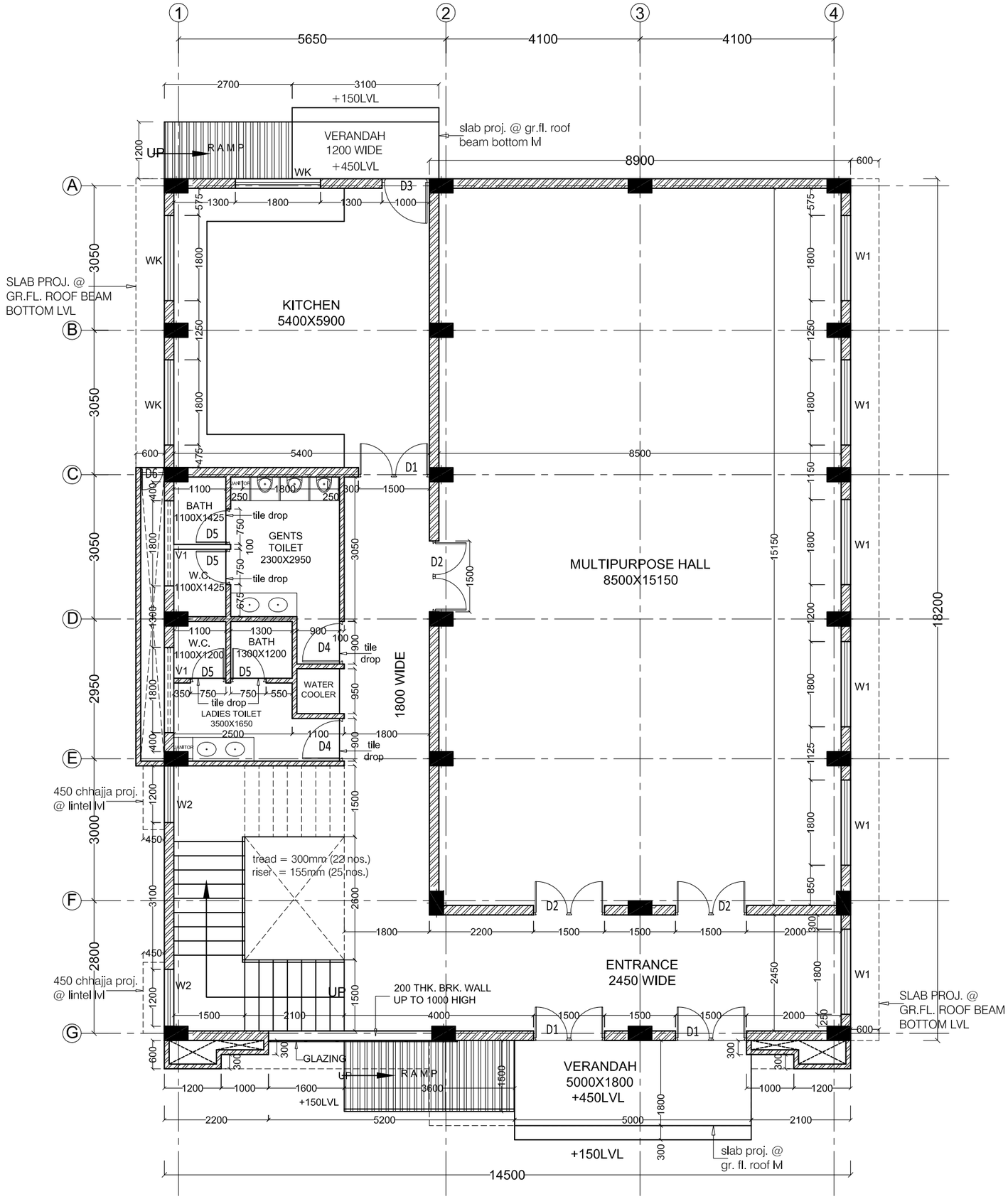
LEGEND

S.NO.	SYMBOL	PARTICULAR
1.		LED STREET LIGHT-1X48W
2.		LED STREET LIGHT-1X25W

PROJECT	- HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE
CLIENT	- INDORE MUNICIPAL CORPORATION
DRAWING	- STREET LIGHT LAYOUT PLAN (KANADIYA EXTENSION)
DRG NO -	E-01
SCALE -	N.T.S.

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2.3.8 Social Infrastructure Building Drawings



GROUND FLOOR PLAN

SCHEDULE OF DOORS

S.NO.	TYPE	SIZE	DESCRIPTION
1.	D1	1500X2400	ALLUMINIUM FRAME GLAZED DOOR
2.	D2	1500X2450	FLUSH DOOR (PRESSED STEEL FRAME)
3.	D3	1000X2450	FLUSH DOOR (PRESSED STEEL FRAME)
4.	D4	900X2150	FLUSH DOOR (PRESSED STEEL FRAME)
5.	D5	750X2150	FLUSH DOOR (PRESSED STEEL FRAME)
6.	D6	500X2150	M.S. TRAP DOOR(M.S. ANGLE FRAME)
7.	D7	1000X2150	M. S. DOOR (AT TERRACE)

SCHEDULE OF WINDOWS & VENTILATOR

S.NO.	TYPE	SIZE	DESCRIPTION
1.	W1	1800X1500	ALLUMINIUM FRAME GLAZED SLIDING WINDOW
2.	W2	1200X1500	ALLUMINIUM FRAME GLAZED FIXED WINDOW
3.	WK	1800X1200	ALLUMINIUM FRAME GLAZED SLIDING WINDOW
4.	V1	1800X600	ALUMINIUM LOUVERED VENTILATOR with exhaust fan provision

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2 ALL DIMENSIONS IN THE DRAWING ARE TO BE READ AND NOT TO BE MEASURED.

3 ALL DIMENSIONS SHALL BE CO-RELATED WITH STRUCTURAL AND SERVICE DRAWINGS AND ANY AMBIGUITY SHALL BE IMMEDIATELY BROUGHT TO THE NOTICE OF THE ARCHITECT BEFORE THE COMMENCEMENT OF WORK.

4 THIS DRAWING SHALL SUPERSEDE ITS PREVIOUS REVISIONS.

SPECIFIC NOTES

1 ALL LEVELS SHALL BE CROSS CHECKED WITH THE ARCHITECT BEFORE STARTING ON SITE.

2 ALL BRICK WALLS ARE 200/100 MM THK. UNLESS OTHERWISE SPECIFIED.

3 ALL TILE DROPS ARE 15MM UNLESS OTHERWISE SPECIFIED.

4 ALL JUNCTIONS BETWEEN CONCRETE AND ANY OTHER MATERIAL TO BE PLASTERED ONLY AFTER FIXING CHICKEN MESH.

5 EMBEDDED PLATE SHALL BE PROVIDED AT LINTEL LVL. WHERE DOOR / WINDOW IS ADJOINING TO COLUMN.

6 PERIPHERIAL PLINTH PROTECTION AS / TENDER ITEM. 7ALL DIM. ARE IN MM.

PROJECT - HOUSING FOR ALL UNDER PRADHAN MANTRI AWAS YOJNA (PMAY),INDORE

CLIENT - INDORE MUNICIPAL CORPORATION

DRAWING - COMMUNITY HALL (KANADIYA EXTENSION)

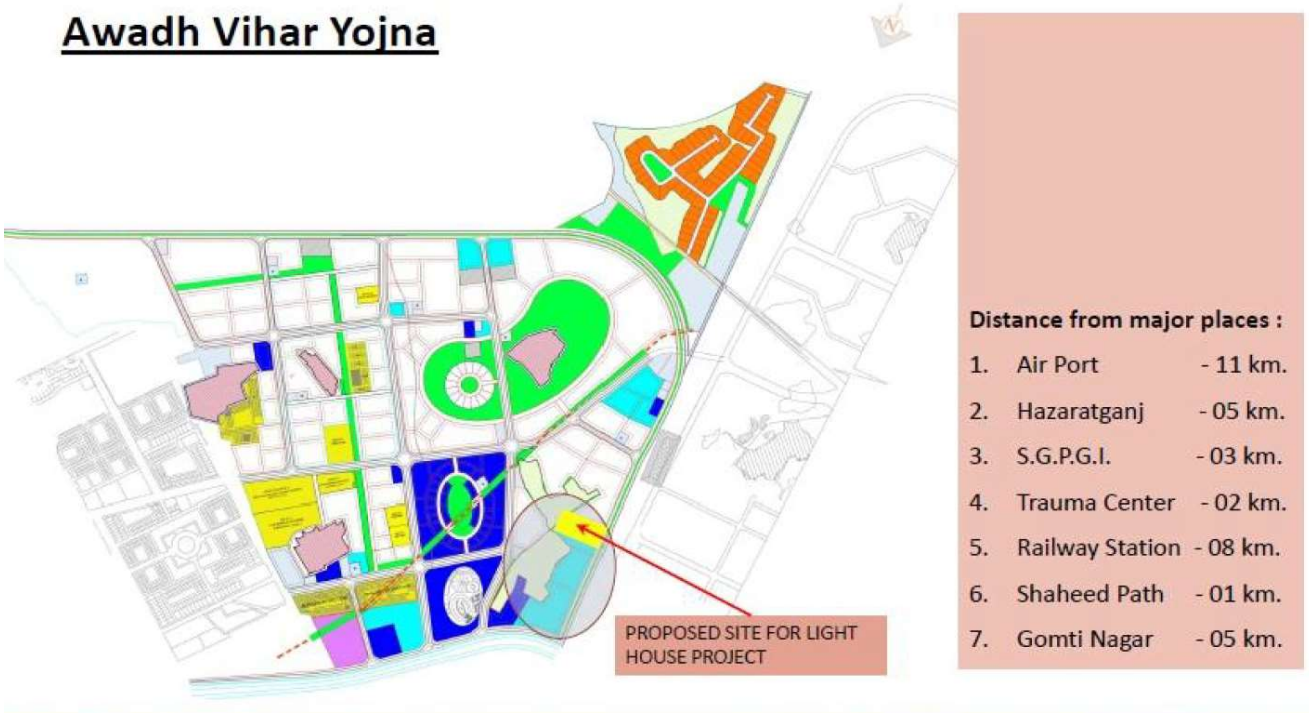
DRG NO - COMH-01

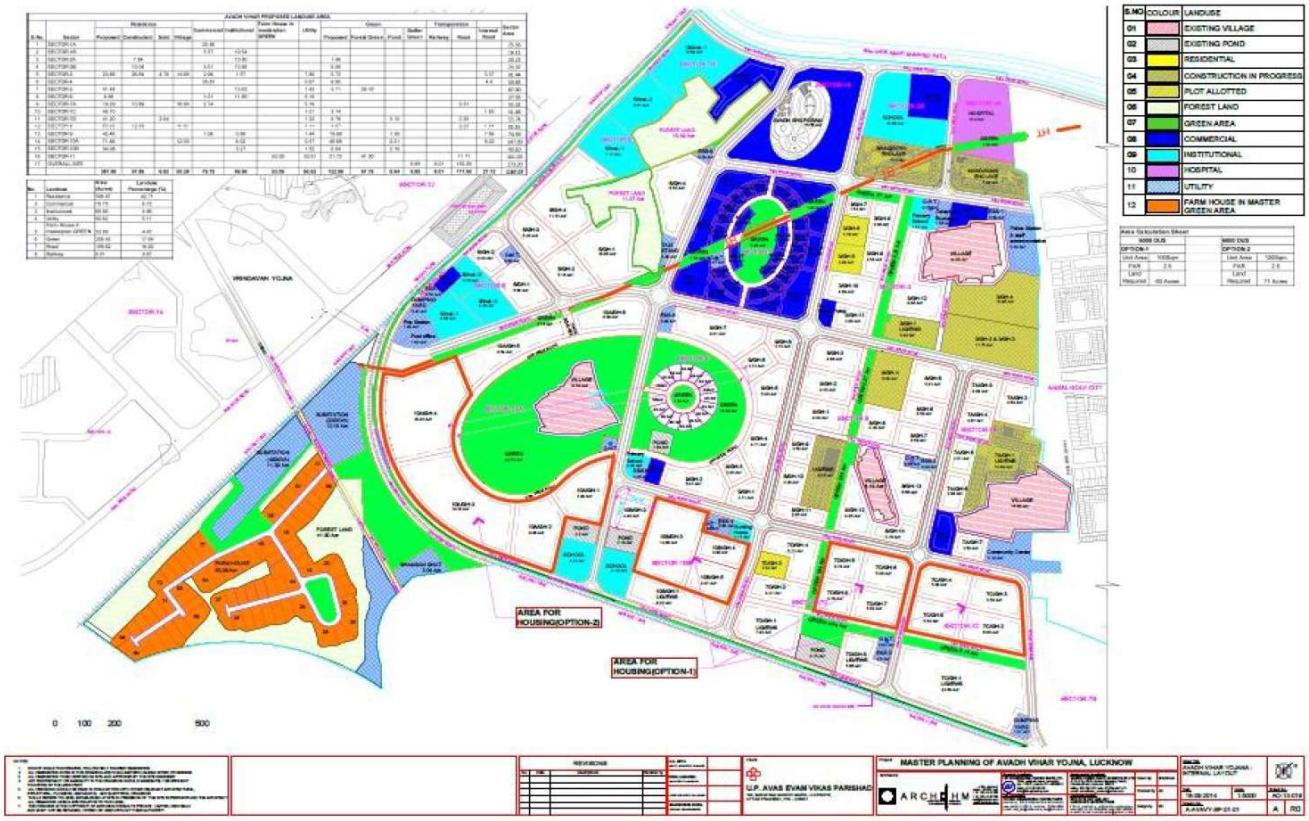
SCALE - N.T.S.

MEHTA & ASSOCIATES
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102. 1st floor, Navneet Plaza, 5/2, Old Palasia, Indore-452001
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2.4 LHP 4 Uttar Pradesh

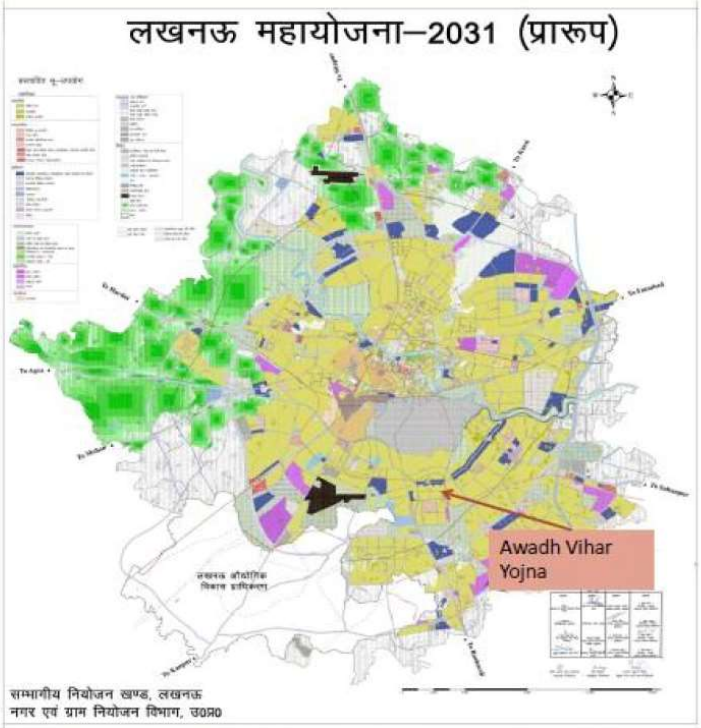
2.4.1 Location





LOCATION MAP





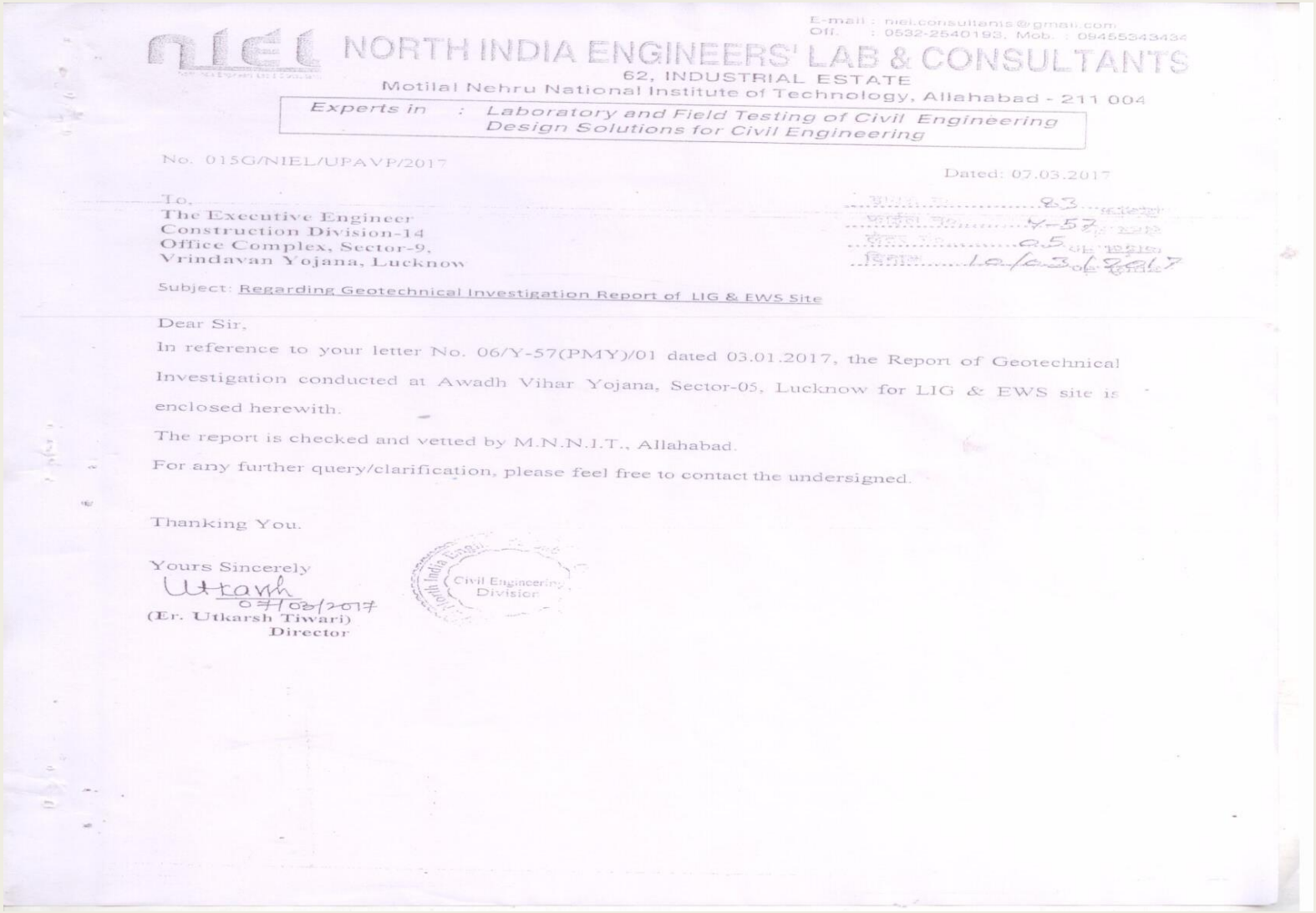


2.4.2 Total Station Survey Map



2.4.3 Soil Testing Report

Proposed site : Soil Test Report



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NORTH INDIA ENGINEERS' LAB & CONSULTANTS

62, INDUSTRIAL ESTATE
Motilal Nehru National Institute of Technology, Allahabad - 211 004

Experts in : Laboratory and Field Testing of Civil Engineering
Design Solutions for Civil Engineering

No. 015G/NIEL/UPAVP/2017 Dated: 07.03.2017

To,
The Executive Engineer
Construction Division-14
Office Complex, Sector-9,
Vrindavan Yojana, Lucknow

83
Y-57
05
10/03/2017

Subject: Regarding Geotechnical Investigation Report of LIG & EWS Site

Dear Sir,

In reference to your letter No. 06/Y-57(PMY)/01 dated 03.01.2017, the Report of Geotechnical Investigation conducted at Awadh Vihar Yojana, Sector-05, Lucknow for LIG & EWS site is enclosed herewith.

The report is checked and vetted by M.N.N.I.T., Allahabad.

For any further query/clarification, please feel free to contact the undersigned.

Thanking You.

Yours Sincerely
07/03/2017
(Er. Utkarsh Tiwari)
Director

North India Engineers' Lab & Consultants Civil Engineering Division

Proposed site : Soil Test Report

A

Report

on

Sub-Soil Exploration

for

Design of Foundation

of

Multi Storeyed Buildings (EWS & LIG)

at

Awadh Vihar Yojna, Sector-05, Lucknow (U.P.)

Submitted to

U.P.Avas Avam Vikas Parishad

Construction Div.-14, Lucknow (U.P.)

by

GEOTECHNICAL ENGINEERING LABORATORY
NORTH INDIA ENGINEERS' LAB & CONSULTANTS
(An ISO 9001:2008 Certified Company)
Shed No.62, Industrial Estate, M.N.N.I.T. Allahabad
Allahabad

North India Engineer's Lab & Consultants
Civil Engineering Division
Allahabad

Proposed site : Soil Test Report

ACKNOWLEDGEMENT

The team is thankful to Er. P.K.Singh, Executive Engineer of U.P. Avas Avam Vikas Parishad, Construction Division-14, Lucknow for the sponsoring the project and co-operation extended during the field investigations.

Team is also thankful to the staff of North India Engineers' Lab & Consultants for their co-operation and assistance rendered during the project.

Utkarsh
27/02/2017
(Er. Utkarsh Tiwari)
Director

GEOTECHNICAL ENGINEERING LABORATORY
NORTH INDIA ENGINEERS' LAB & CONSULTANTS
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Allahabad

Proposed site : Soil Test Report

Geotechnical Investigation for the Design
of
Foundation for Multi Storeyed Buildings (EWS & LIG)
at
Awadh Vihar Yojana, Sector-05, Lucknow

Project	:	Sub-soil Exploration for the Design of Foundation for Multi Storeyed Buildings (EWS & LIG).
Agency	:	U.P. Avas Avam Vikas Parishad, Construction Division-14, Lucknow
Site	:	Awadh Vihar Yojana,Sector-5, Lucknow

The investigations have been carried out according to the requirements and limitations of the client during January-February, 2017.

Team : Evaluation of the Geotechnical properties of the soils of various strata & subsequent analysis, and the final report for the project have been carried out by the team comprising of:

(i) Er. Utkarsh Tiwari.
(ii) Dr. S.G.Tripathi, Ph.D. (Geotech.)

The team acknowledge the assistance given by Shri. Dinesh Kumar Soni, Laboratory Technician and Mr.R.K.Shukla & Mr.Vaibhav Singh, Laboratory Assistant for supervision of the field and laboratory works.

The assistance rendered by the staff of U.P. Avas Avam Vikas Parishad, Construction Division-14, Lucknow during the field investigation work is also acknowledged.

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7/3/17

M.N. National Institute of Technology * Civil Engineering Department * Allahabad

Uttarh

Civil Engineering Division

Proposed site : Soil Test Report

1.0 INTRODUCTION

The proper design of Civil Engineering Structure requires adequate knowledge of subsurface condition of the site of the structure. The aim of the present Geotechnical Investigations has been to determine the sub-soil characteristics for the design of Foundation for multi storeyed buildings (EWS & LIG) for at Awadh Vihar Yojana,Sector-5, Lucknow.

The investigations were carried out to evaluate the load bearing and settlement characteristics of the soil for the design of foundation as required by the agency. Other allied properties of soils were also studied and are reported herein in this report.

The basic consideration in the design of the foundations is that of safety, dependability, functional utility and economy. Amongst these, tolerable settlement and safety against shear failure are of far most important w.r.t. soil conditions. Therefore for a safe and functional foundation, the allowable bearing pressure is worked out from shear as well as permissible settlement considerations.

For the evaluation of safe ultimate load bearing capacity of soil failing in shear, various theoretical analysis and empirical formulae are available e.g. Terzaghi (1943), Skempton (1951), Meyerhoff (1951, 1953), Hansen (1972) Chan and Devidson (1973) etc. These formulae give value of load bearing capacity of soil as function of shear strength parameters shape, depth, inclination of the foundation and several other parameters. Further field tests, such as standard penetration tests, provide empirical relationships for assessing allowable bearing pressure from 'N-value'.

In the present investigations, the strength parameters viz. Cohesion (Cu) and angle of internal friction (Φ_u) have been evaluated from the Triaxial Test/Direct shear test, using undisturbed/Remoulded samples of various strata recovered during the field investigations. In addition SPT test have been carried out to supplement the results of laboratory studies. The results of field and laboratory investigation carried out would provide the designer the necessary data for evaluating the allowable bearing pressure for shear failure.

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The settlement studies are based on consolidation properties of the soil, for which Oedometer tests have been carried out. Using Terzaghi's analysis or Scot's method using Undisturbed / Remoulded Samples recovered from field. The value of settlements has been obtained.

The studies reported herein i.e. C_u , Φ_u parameters, C_c and other characteristics of soil strata would provide the designer with necessary data for the selection of the type of foundation and thereby the design of the foundation.

2.0 FIELD WORK AND LABORATORY INVESTIGATIONS

2.1 Field Work

The number, type, location, size and depth of explorations of boreholes are dependent upon the nature and size of project and on the degree of complexity and critical nature of the surface conditions.

In the present case, the field work consists of advancing three bore holes at the site of U.P. Avas Avam Vikas Parishad, CD-14, Lucknow at Awadh Vihar Yojana, Sector-05 in Lucknow District as decided by the department. The borehole was of 12.5 cm. in diameter. Four boreholes (Nos.1, 3, 5 & 6) were explored up to 20.0m and two bore holes (Nos. 2 & 4) up to 30.0m below G.L. The field work consisted of drilling of bore hole, preparation of bore-log charts based on field identification, conducting standard penetration test (SPT) at every 1.5 m. depth. Disturbed and undisturbed samples were collected for various laboratory tests. The location of water table was also to be observed in the investigated bore holes.

2.2 Laboratory Investigations:

These were carried out on disturbed/undisturbed soil samples collected during the fieldwork for determination of moisture content, specific gravity, bulk and dry densities, triaxial tests (unconsolidated undrained), Direct Shear Tests and Oedometer tests using undisturbed samples, and classification tests including determination of Atterberg's limits on representative disturbed samples. A brief remarks on these tests are as follows:

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Proposed site : Soil Test Report

(i) **Soil Classification Tests:**

These tests were performed as per IS: 2720(Part IV) 1965, IS: 1498-1970 and IS:, 2720 (Part V)- 1970. The soil classification is based on Mechanical analysis and Atterberg's limits on disturbed representative samples from bore holes according to IS soil classification system. The results are reported in the form of bore log chart for the boreholes.

(ii) **Bulk Density, Moisture Content and Specific Gravity of Soils:**

These tests were carried out as per IS: 2720(Part-III/ Sec.-1 & 2, 1980), IS: 2720 (Part II),1973. The Bulk Density and Moisture content in the field were determined from undisturbed samples recovered from the liners and dry density was computed from these. Specific gravity of the soil of these samples was also determined in the laboratory. The results are given in bore log chart for the boreholes.

(iii) **Shear Strength Tests:**

These tests were performed as per IS: 2720 (Part-13)-1986 and IS: 2720 (Part-11)-1993. The Direct Shear tests and triaxial shear strength tests were carried out using at least three undisturbed / remoulded samples in each case. Strength envelopes were plotted to determine the values of shear strength parameters C_u and φ_u. These values are also given in the respective bore log charts.

(iv) **Consolidation Tests:**

These tests were carried out as per IS: 2720(Part-15)-1986. Consolidated tests were performed on undisturbed/remoulded samples from the given location as per above-mentioned IS code. The value of compression index Cc was obtained from a plot between void ratio (e) on natural scale and pressure (p) on logarithmic scale.

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3.0 TEST RESULTS

The results of various tests conducted at site and in the laboratory are given in the bore-log charts. The location of borehole was decided by the agency.

4.0 DISCUSSION OF TEST RESULTS

The results for the various boreholes are discussed as follows.

4.1 Strata and their Engineering Properties:

The soil classification according to IS classification indicates presence of four types of strata viz. CI, CL, ML & SM. The general characteristics associated with these types of strata are given below:

4.1.2 Stratum CI:

This stratum consists of silty clay with medium plasticity and also experience high volume changes when subjected to moisture fluctuations. Sometimes a little moisture can produce high differential settlements. This type of soil is more or less impervious in nature. This stratum was found between 6.0 m to 7.2m in bore hole No. 1. In bore hole No. 4, it was present at the top up to 2.5m depth, between 9.0m to 17.5m and at the bottom from 21.0m to depth of exploration of 30.0m. This stratum was also found at bottom depth from 18.0m to depth of exploration of 20.0m in bore hole No.5.

4.1.3 Stratum CL:

This type of soil is characterised by presence of inorganic clays of low plasticity. These soils have very low permeability and low compressibility. This stratum was encountered at middle depth between 6.5m to 13.5 in bore hole No.5 only.

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4.1.4 Stratum ML :

This stratum is characterized by presence of inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with none to low plasticity. It has none to low dry strength and exhibit a quick reaction. This stratum was observed with varying thicknesses at various depths in all the investigated bore holes. It has good bearing value in the natural condition. In general, this foundation soils are of semi-pervious to impervious in nature and it is suggested that measures to control permeability may be considered because it is susceptible to liquefaction.

4.1.5 Stratum SM:

The stratum SM contains fine sand with appreciable percentage of fines which are predominantly sand size. This strata is semi-impervious, has fairly good strength when compacted even in saturated condition. Further its susceptibility to volume changes such as shrinkage & swelling is little. At present site, this stratum was present only in bore hole No.6 between 13.0m to 17.0 m depth.

4.2 N – Value:

Standard penetration tests have been carried out and N-values are determined at every 1.5m depth and these have been reported in the bore log chart. At the present site N – values indicated that the consistency of soil is stiff at shallow depths and hard consistency at lower depths.

5.0 BEARING CAPACITY AND RECOMMENDATIONS

The sub soil investigation work was carried out to find the soil parameters in order to design the foundation for Multi-storeyed buildings (EWS & LIG) of U.P. Avas Avam Vikas Parishad, Construction Division-14, Lucknow at Awadh Vihar Yojana, Sector-05, in Lucknow District. Four boreholes (Nos. 1, 3, 5 & 6) were investigated at site up to a depth of 20.0m & the other two bore hole (Nos. 2 & 4) up to a depth of 30.0m from the existing ground level.

At the present site, in bore hole No. 1, non-plastic silty soil (ML) was found with varying thicknesses at different depths accept from 6.0m to 7.2m depth where clay with medium compressibility (CI) was observed.

In bore hole Nos. 2 and 3, Non-plastic silty soil (ML) was found with varying thicknesses at various depths throughout the investigated depth.

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In bore hole No. 4, clay with medium compressibility (CI) was present at top up to 2.5 m followed by non-plastic silty soil (ML) up to 9.0m depth. After this stratum, clay with medium compressibility (CI) was found up to 17.5m. Again, non-plastic silty soil (ML) was found up to 21.0m depth followed by clay with medium compressibility (CI) up to depth of exploration of 30.0m.

In bore Hole No. 5, non-plastic silty soil (ML) was present at the top up to 6.5m followed by clay with low compressibility (CL) up to 13.5m depth. After this stratum, again non-plastic silty soil (ML) was found up to 18.0m depth followed by clay with medium compressibility (CI) up to depth of exploration of 20.0m.

In bore hole No. 6, non-plastic silty soil (ML) was present at the top up to 13.0m with variable thicknesses from existing ground level followed by non-plastic silty sand (SM) up to 17.0m depth. After this stratum, again non-plastic silty soil (ML) was present up to depth of exploration of 20.0m.

At the present site, water table was encountered at a depth of **14.0m** in all the investigated bore holes.

Based on soil test results and N-values, the net safe bearing capacity / allowable bearing pressure for a raft foundation placed at a depth of **1.5m , 3.0m and 4.5m** below existing ground level comes out to be **11.0 t/m^2 , 13.0 t/m^2** and **15.0 t/m^2** respectively with respect to settlement. The allowable settlement was considered as 50mm.

Typical curves of grain size distribution, tri-axial test and direct shear test for each bore hole are presented after the bore-log charts.

Final load on foundation would be determined by the structural designer and final type & dimensions of the foundation for multi storeyed buildings for [illegible] & LIG would be decided by the design engineer using bore log charts.

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7/3/17

Utkarsh 27/02/2017

(Er. Utkarsh Tiwari)
Director

GEOTECHNICAL ENGINEERING LABORATORY
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Allahabad

North India Engineer's Lab & Consultants (Civil Engineering Division)

Proposed site : Soil Test Report

Geotechnical Engineering Division
North India Engineers' Lab & Consultants
Shed No. 62, Industrial Estate, M.N.N.I.T. Allahabad

BORE LOG CHART

Site: U.P.A.V.P., Lucknow

Structure: EWS, Multi Storeyed Building

Bore Hole No.: 1

Depth (metre)	SPT Value	Soil Description	Classification	Particle Size Distribution %				Natural Moisture Content	Bulk Unit Weight	Dry Unit Weight	Specific Gravity	Atterberg's Limits in %			Shear Strength Parameters		Compression Index
				Gravel	Sand	Silt	Clay	%	gm/cc	gm/cc		L.L.	P.L.	P.I.	C_u kg/cm²	φ_u Degree	(C_c)
0.0																	
1.5	9																
3.0	18	Non-Plastic Silty Soil	ML	1.56	6.76	88.75	2.93	10.6	1.94	1.75	2.64	Non-Plastic			0.03	18	---
4.5	13																
6.0	18																
7.2		Clay with Medium Compressibility	CI	0.00	0.20	71.57	28.23	21.4	2.15	1.77	2.70	39	19	20	0.89	6	0.195
7.5	17																
9.0	20																
10.5	17	Non-Plastic Silty Soil	ML	0.78	28.02	70.06	1.14	20.3	2.16	1.80	2.64	Non-Plastic			0.02	19	---
12.0	28																
13.5	16																
15.0	11																
16.5	34																
18.0	37	Non-Plastic Silty Soil	ML	0.02				21.4	2.30	1.89	2.64	Non-Plastic			0.05	15	---
19.5	41																
20.0																	

Water Table: 14.00 m

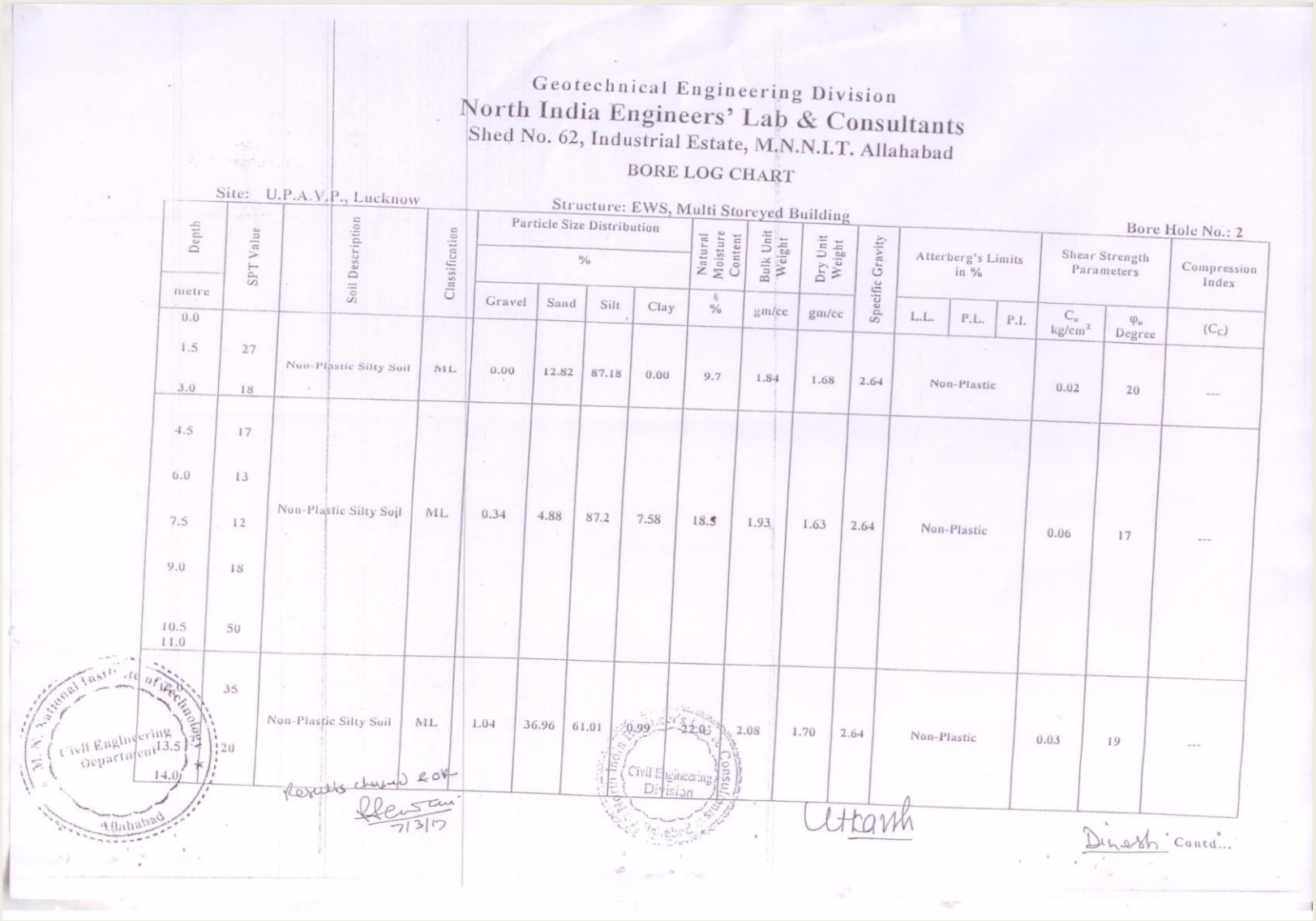
Results checked & OK
7/3/12

Civil Engineering Department

North India Engineer's Lab Civil Engineering Division

Testing Officer

Proposed site : Soil Test Report



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North India Engineers' Lab & Consultants
Shed No. 62, Industrial Estate, M.N.N.I.T. Allahabad

BORE LOG CHART

Site: U.P.A.V.P., Lucknow

Structure: EWS, Multi Storeyed Building

Bore Hole No.: 2

Depth (metre)	SPT Value	Soil Description	Classification	Particle Size Distribution %				Natural Moisture Content	Bulk Unit Weight	Dry Unit Weight	Specific Gravity	Atterberg's Limits in %			Shear Strength Parameters		Compression Index
				Gravel	Sand	Silt	Clay	%	gm/cc	gm/cc		L.L.	P.L.	P.I.	C_u kg/cm^2	φ_u Degree	(C_C)
0.0																	
1.5	27	Non-Plastic Silty Soil	ML	0.00	12.82	87.18	0.00	9.7	1.84	1.68	2.64	Non-Plastic			0.02	20	---
3.0	18																
4.5	17																
6.0	13																
7.5	12	Non-Plastic Silty Soil	ML	0.34	4.88	87.2	7.58	18.5	1.93	1.63	2.64	Non-Plastic			0.06	17	---
9.0	18																
10.5	50																
11.0																	
12.0	35	Non-Plastic Silty Soil	ML	1.04	36.96	61.01	0.99	22.0	2.08	1.70	2.64	Non-Plastic			0.03	19	---
13.5	20																
14.0																	

Results checked & OK
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Civil Engineering Department, M.N.N.I.T. Allahabad

Civil Engineering Division

Contd...

Proposed site : Soil Test Report

Geotechnical Engineering Division

North India Engineers' Lab & Consultants

Shed No. 62, Industrial Estate, M.N.N.I.T. Allahabad

BORE LOG CHART

Site: U.P.A.V.P., Lucknow — Structure: EWS, Multi Storeyed Building — Bore Hole No.: 2

Depth (metre)	SPT Value	Soil Description	Classification	Particle Size Distribution %				Natural Moisture Content	Bulk Unit Weight	Dry Unit Weight	Specific Gravity	Atterberg's Limits in %			Shear Strength Parameters		Compression Index
				Gravel	Sand	Silt	Clay	%	gm/cc	gm/cc		L.L.	P.L.	P.I.	C_u kg/cm^2	φ_u Degree	(C_c)
15.0	28																
16.5	33																
18.0	35	Non-Plastic Silty Soil	ML	16.62	8.92	65.76	8.70	17.2	1.77	1.51	2.64	Non-Plastic			0.14	15	---
19.5	38																
21.0	40																
22.0																	
22.5	26																
24.0	29																
25.5	30	Non-Plastic Silty Soil	ML	3.18	35.02	61.80	0.00	18.3	1.97	1.67	2.64	Non-Plastic			0.02	21	---
27.0	33																
28.5	35																
30.0	38																

Water Table: 14.00 m

results checked & OK

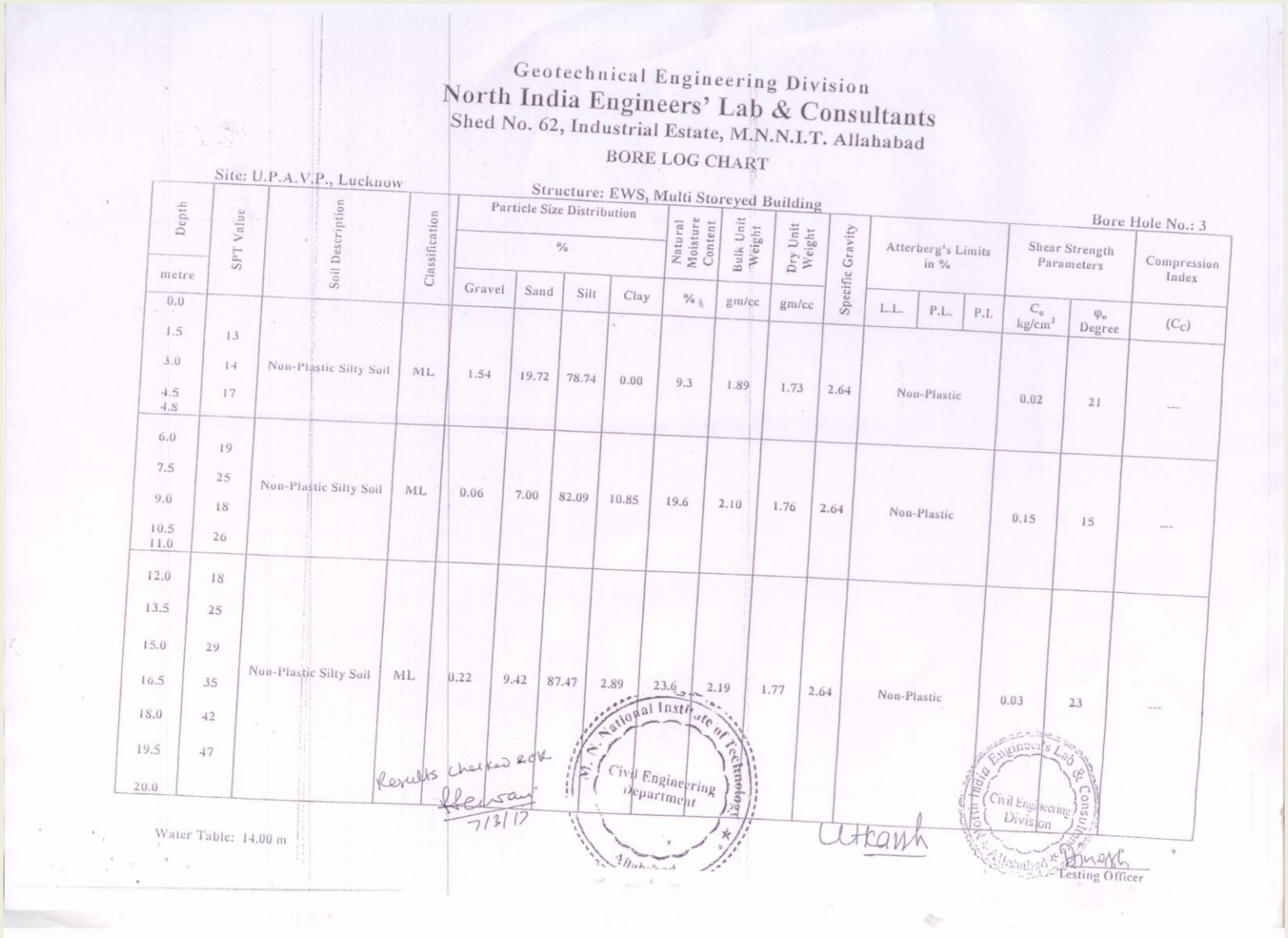
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M.N.N. National Institute of Technology Civil Engineering Department Allahabad

North India Engineer's Lab

Testing Officer

Proposed site : Soil Test Report



Geotechnical Engineering Division
North India Engineers' Lab & Consultants
Shed No. 62, Industrial Estate, M.N.N.I.T. Allahabad
BORE LOG CHART

Site: U.P.A.V.P., Lucknow

Structure: EWS, Multi Storeyed Building

Bore Hole No.: 3

Depth (metre)	SPT Value	Soil Description	Classification	Particle Size Distribution %				Natural Moisture Content	Bulk Unit Weight	Dry Unit Weight	Specific Gravity	Atterberg's Limits in %			Shear Strength Parameters		Compression Index
				Gravel	Sand	Silt	Clay	%	gm/cc	gm/cc		L.L.	P.L.	P.I.	C_u kg/cm^2	φ_u Degree	(C_C)
0.0																	
1.5	13																
3.0	14	Non-Plastic Silty Soil	ML	1.54	19.72	78.74	0.00	9.3	1.89	1.73	2.64	Non-Plastic			0.02	21	---
4.5	17																
4.8																	
6.0	19																
7.5	25	Non-Plastic Silty Soil	ML	0.06	7.00	82.09	10.85	19.6	2.10	1.76	2.64	Non-Plastic			0.15	15	---
9.0	18																
10.5	26																
11.0																	
12.0	18																
13.5	25																
15.0	29																
16.5	35	Non-Plastic Silty Soil	ML	0.22	9.42	87.47	2.89	23.6	2.19	1.77	2.64	Non-Plastic			0.03	23	---
18.0	42																
19.5	47																
20.0																	

Water Table: 14.00 m

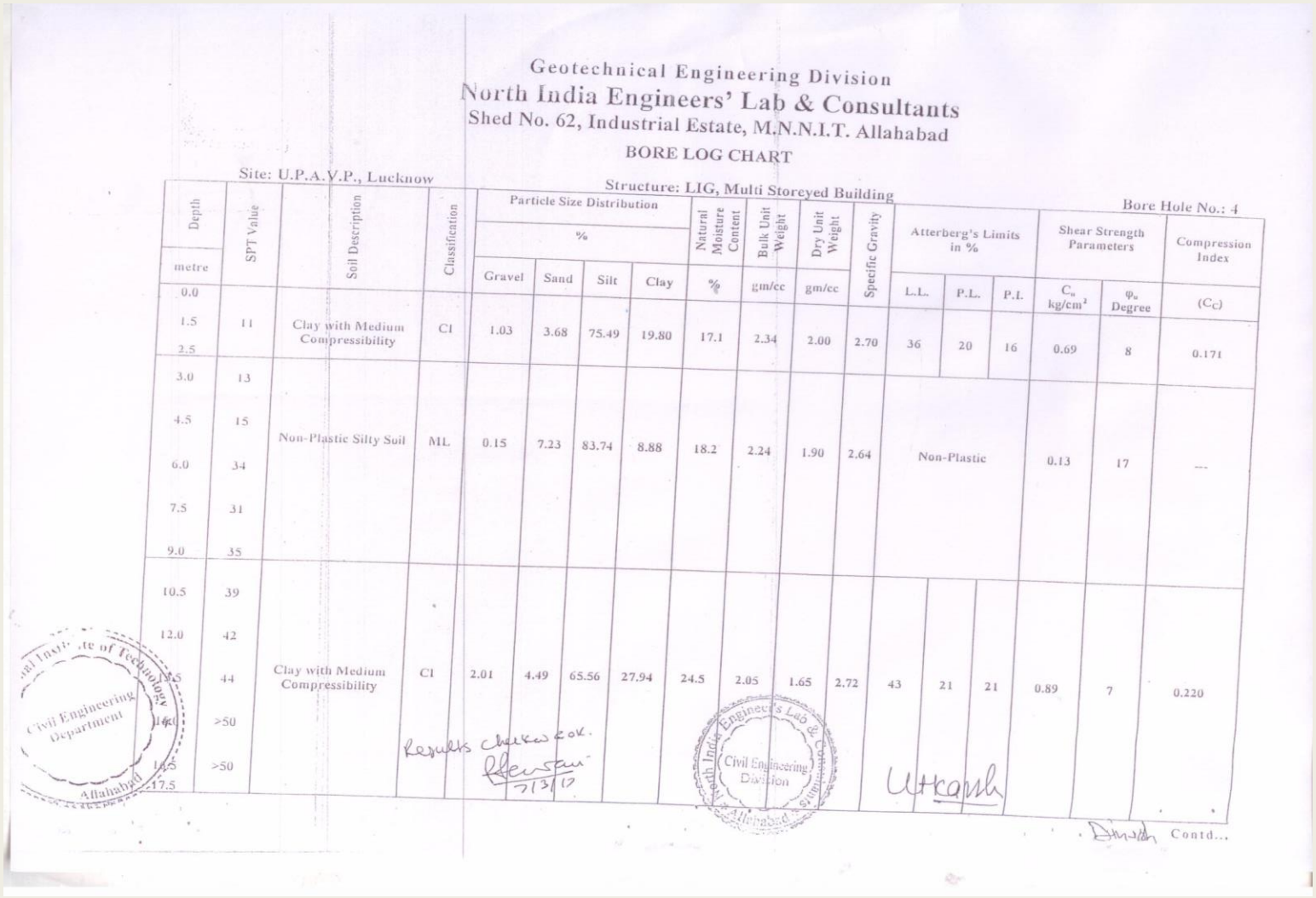
Results checked ok
7/3/17

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Civil Engineering Division
Allahabad

Testing Officer

Proposed site : Soil Test Report



Geotechnical Engineering Division
North India Engineers' Lab & Consultants
Shed No. 62, Industrial Estate, M.N.N.I.T. Allahabad

BORE LOG CHART

Site: U.P.A.V.P., Lucknow

Structure: LIG, Multi Storeyed Building

Bore Hole No.: 4

Depth (metre)	SPT Value	Soil Description	Classification	Particle Size Distribution %				Natural Moisture Content	Bulk Unit Weight	Dry Unit Weight	Specific Gravity	Atterberg's Limits in %			Shear Strength Parameters		Compression Index
				Gravel	Sand	Silt	Clay	%	gm/cc	gm/cc		L.L.	P.L.	P.I.	C_u kg/cm²	φ_u Degree	(C_C)
0.0																	
1.5	11	Clay with Medium Compressibility	CI	1.03	3.68	75.49	19.80	17.1	2.34	2.00	2.70	36	20	16	0.69	8	0.171
2.5																	
3.0	13																
4.5	15	Non-Plastic Silty Soil	ML	0.15	7.23	83.74	8.88	18.2	2.24	1.90	2.64	Non-Plastic			0.13	17	---
6.0	34																
7.5	31																
9.0	35																
10.5	39																
12.0	42																
[illegible]	44	Clay with Medium Compressibility	CI	2.01	4.49	65.56	27.94	24.5	2.05	1.65	2.72	43	21	21	0.89	7	0.220
[illegible]	>50																
16.5	>50																
17.5																	

Results checked & OK. 7/3/17

Civil Engineering Department, [illegible] Institute of Technology, Allahabad

North India Engineers Lab & Consultants, Civil Engineering Division, Allahabad

Contd...

Proposed site : Soil Test Report

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BORE LOG CHART

Site: U.P.A.V.P., LIG, Lucknow

Structure: Multi Storeyed Building

Bore Hole No.: 4

Depth (metre)	SPT Value	Soil Description	Classification	Particle Size Distribution %				Natural Moisture Content %	Bulk Unit Weight gm/cc	Dry Unit Weight gm/cc	Specific Gravity	Atterberg's Limits in %			Shear Strength Parameters		Compression Index
				Gravel	Sand	Silt	Clay					L.L.	P.L.	P.I.	C_u kg/cm^2	φ_u Degree	(C_C)
18.0	32	Non-Plastic Silty Soil	ML	4.16	3.55	83.96	8.33	26.3	1.87	1.48	2.64	Non-Plastic			0.14	17	---
19.5	30																
21.0	28																
22.5	34	Clay with Medium Compressibility	CI	7.36	4.33	68.43	19.88	20.6	1.99	1.65	2.70	38	17	21	0.70	8	0.186
24.0	43																
25.5	>50																
27.0	>50																
28.5	>50																
30.0	>50																

Water Table: 14.00 m

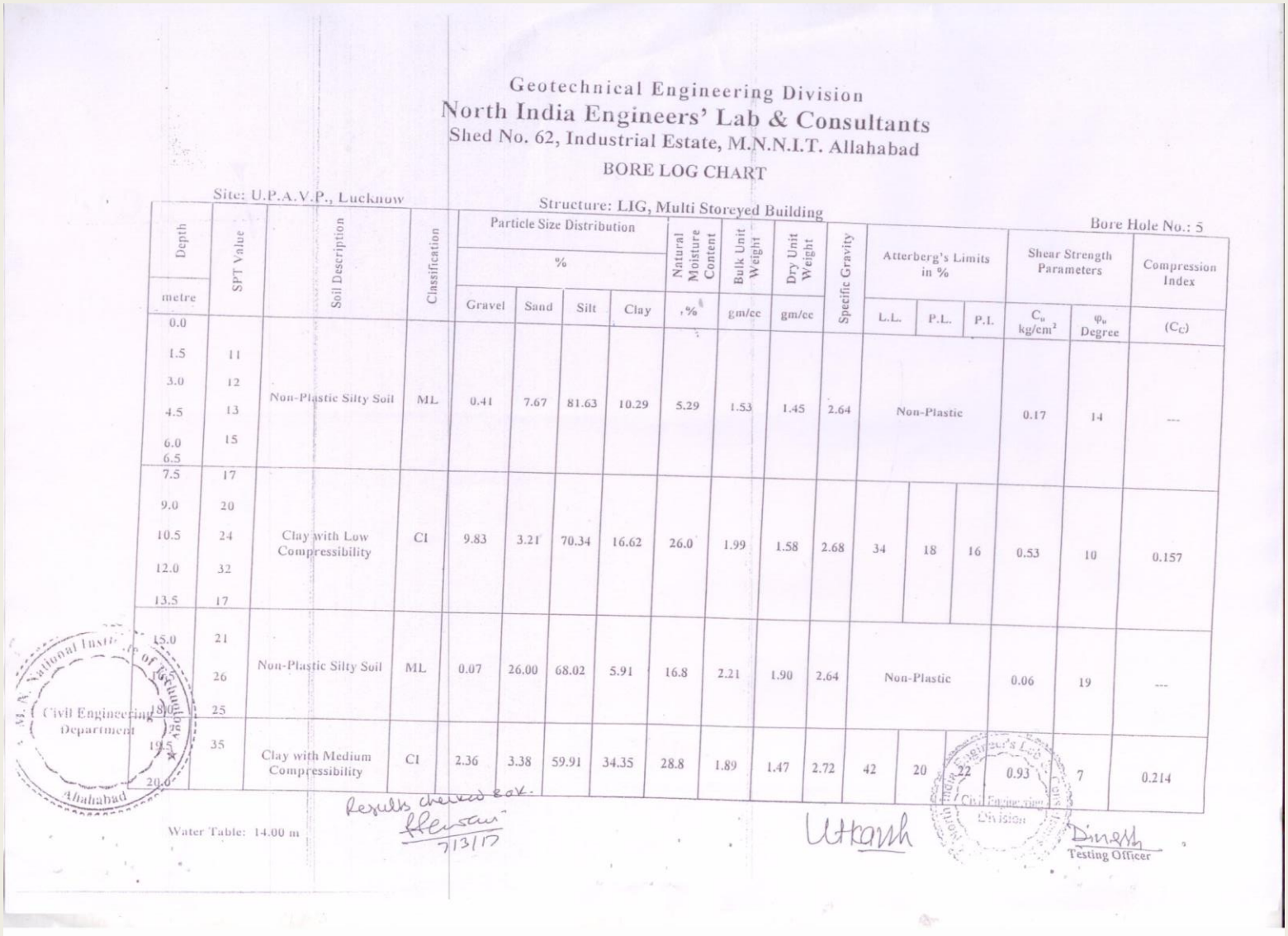
Results checked & ok
7/3/17

M.N.N.I.T. National Institute of Technology Civil Engineering Department Allahabad

Lab & Consultants Civil Engineering Division

Testing Officer

Proposed site : Soil Test Report



Geotechnical Engineering Division
North India Engineers' Lab & Consultants
Shed No. 62, Industrial Estate, M.N.N.I.T. Allahabad

BORE LOG CHART

Site: U.P.A.V.P., Lucknow

Structure: LIG, Multi Storeyed Building

Bore Hole No.: 5

Depth (metre)	SPT Value	Soil Description	Classification	Particle Size Distribution % Gravel	Sand	Silt	Clay	Natural Moisture Content %	Bulk Unit Weight gm/cc	Dry Unit Weight gm/cc	Specific Gravity	Atterberg's Limits in % L.L.	P.L.	P.I.	Shear Strength Parameters C_u kg/cm²	φ_u Degree	Compression Index (C_c)
0.0																	
1.5	11																
3.0	12	Non-Plastic Silty Soil	ML	0.41	7.67	81.63	10.29	5.29	1.53	1.45	2.64	Non-Plastic			0.17	14	---
4.5	13																
6.0	15																
6.5																	
7.5	17																
9.0	20																
10.5	24	Clay with Low Compressibility	CI	9.83	3.21	70.34	16.62	26.0	1.99	1.58	2.68	34	18	16	0.53	10	0.157
12.0	32																
13.5	17																
15.0	21																
16.5	26	Non-Plastic Silty Soil	ML	0.07	26.00	68.02	5.91	16.8	2.21	1.90	2.64	Non-Plastic			0.06	19	---
18.0	25																
19.5	35	Clay with Medium Compressibility	CI	2.36	3.38	59.91	34.35	28.8	1.89	1.47	2.72	42	20	22	0.93	7	0.214
20.0																	

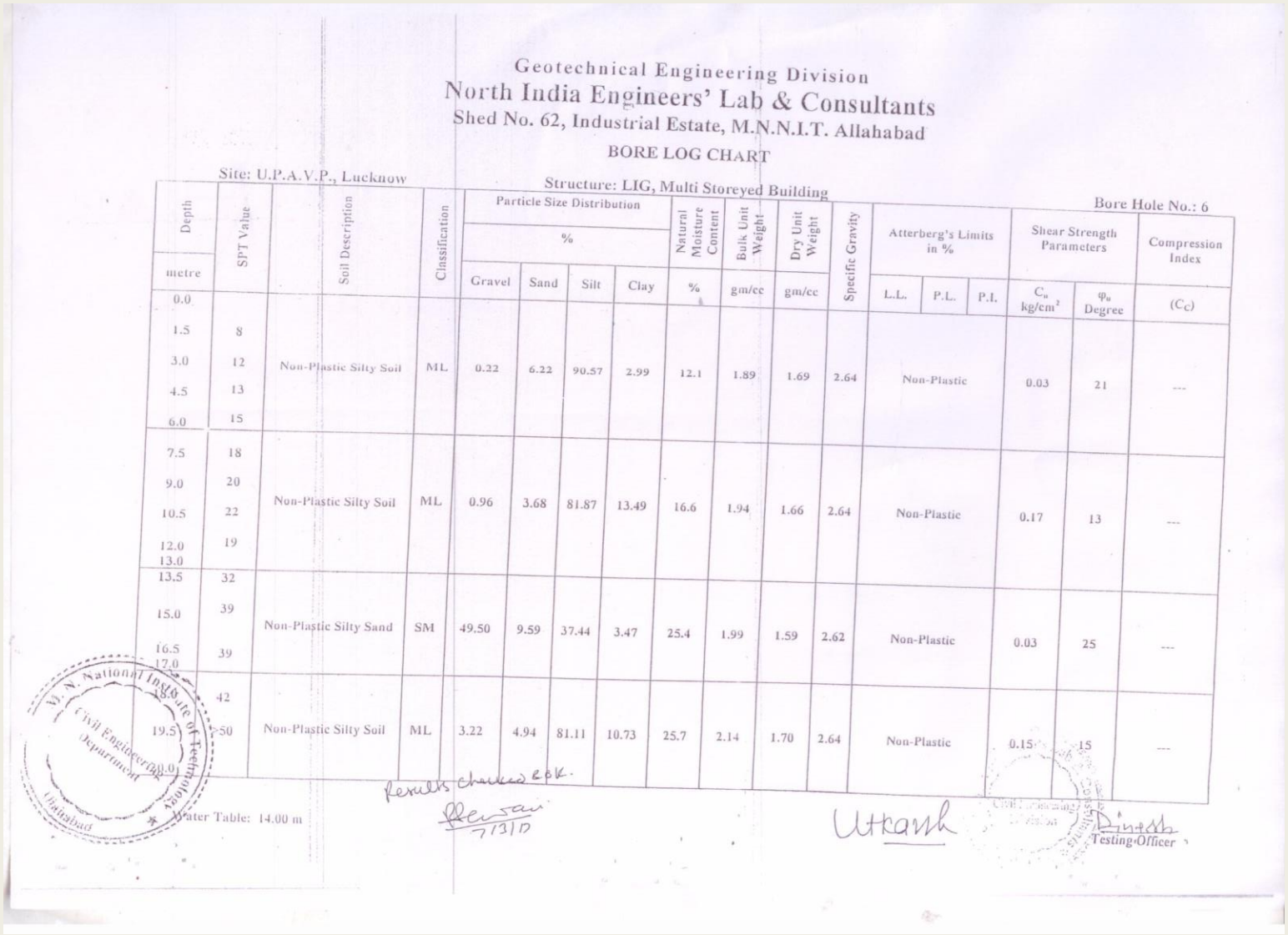
Water Table: 14.00 m

Results checked & ok.
7/3/17

Civil Engineering Department
Allahabad

Testing Officer

Proposed site : Soil Test Report



Geotechnical Engineering Division
North India Engineers' Lab & Consultants
Shed No. 62, Industrial Estate, M.N.N.I.T. Allahabad

BORE LOG CHART

Site: U.P.A.V.P., Lucknow

Structure: LIG, Multi Storeyed Building

Bore Hole No.: 6

Depth metre	SPT Value	Soil Description	Classification	Particle Size Distribution % Gravel	Sand	Silt	Clay	Natural Moisture Content %	Bulk Unit Weight gm/cc	Dry Unit Weight gm/cc	Specific Gravity	Atterberg's Limits in % L.L.	P.L.	P.I.	Shear Strength Parameters C_u kg/cm²	φ_u Degree	Compression Index (C_C)
0.0																	
1.5	8																
3.0	12	Non-Plastic Silty Soil	ML	0.22	6.22	90.57	2.99	12.1	1.89	1.69	2.64	Non-Plastic			0.03	21	---
4.5	13																
6.0	15																
7.5	18																
9.0	20	Non-Plastic Silty Soil	ML	0.96	3.68	81.87	13.49	16.6	1.94	1.66	2.64	Non-Plastic			0.17	13	---
10.5	22																
12.0	19																
13.0																	
13.5	32																
15.0	39	Non-Plastic Silty Sand	SM	49.50	9.59	37.44	3.47	25.4	1.99	1.59	2.62	Non-Plastic			0.03	25	---
16.5	39																
17.0																	
18.0	42																
19.5	50	Non-Plastic Silty Soil	ML	3.22	4.94	81.11	10.73	25.7	2.14	1.70	2.64	Non-Plastic			0.15	15	---
20.0																	

Water Table: 14.00 m

Results checked ep k.

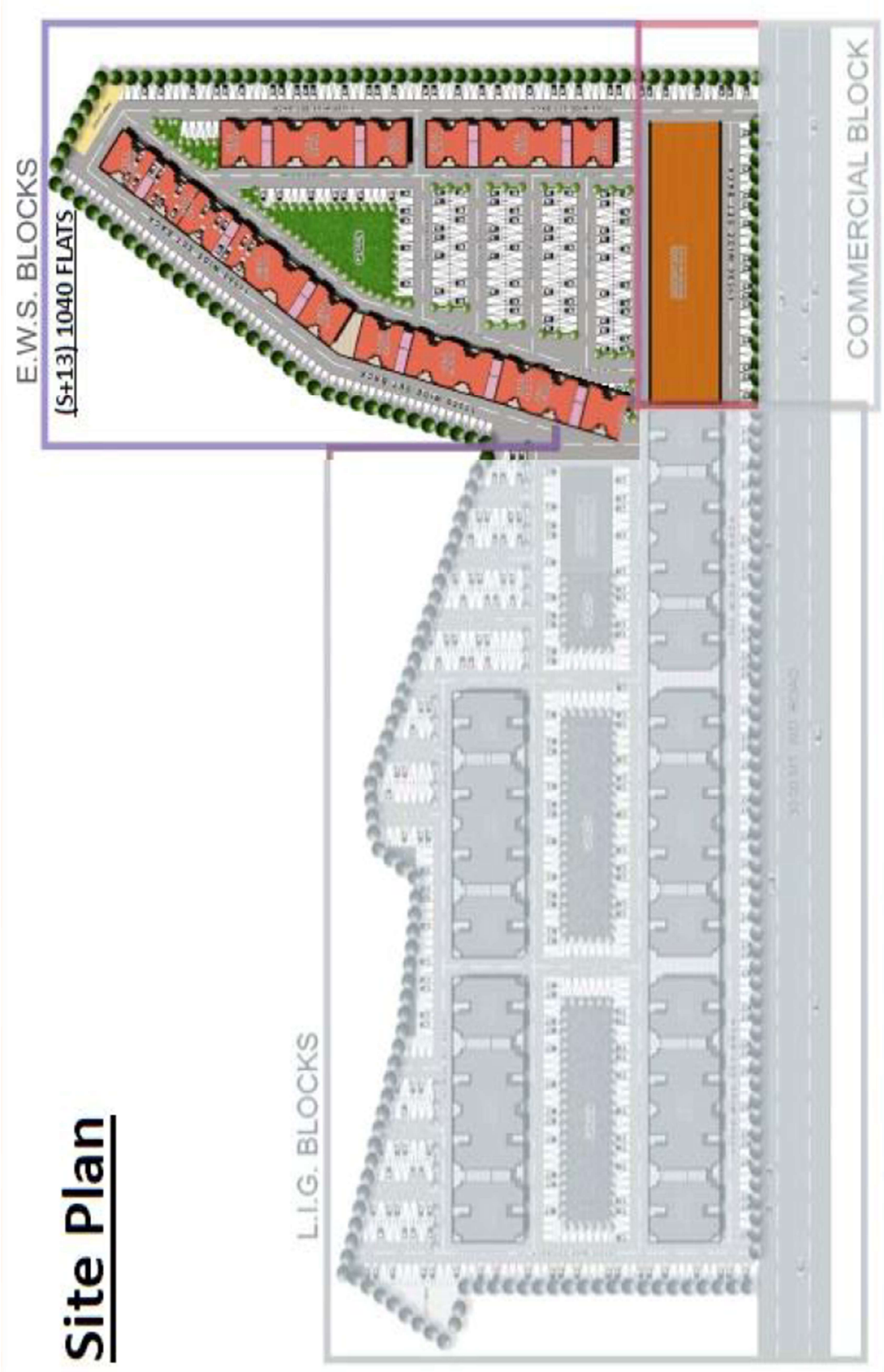
7/3/17

Uttam

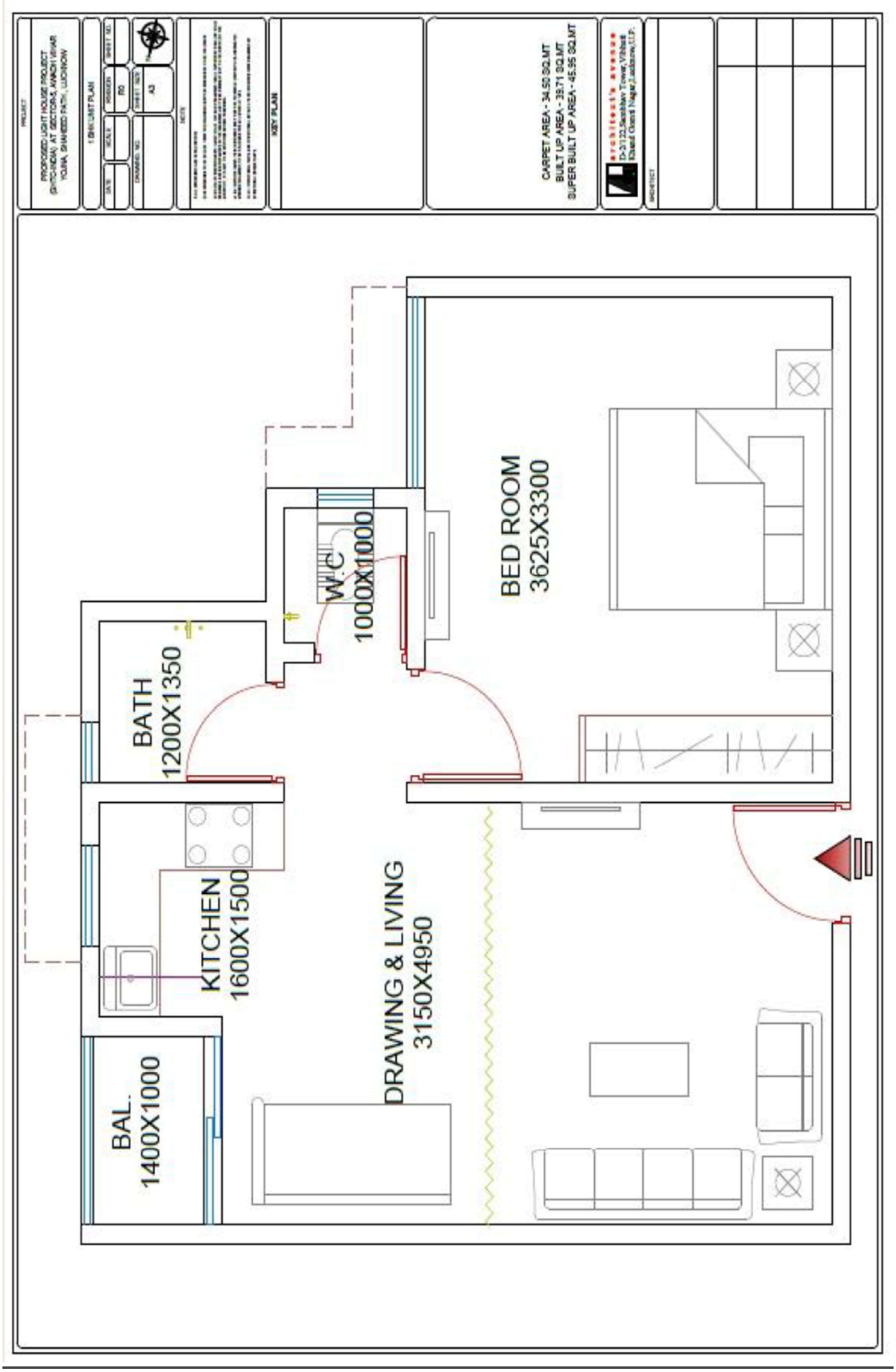
Testing Officer

M.N. National Institute of Technology, Civil Engineering Department, Allahabad

2.4.4 Layout Plan



2.4.5 Unit Plan

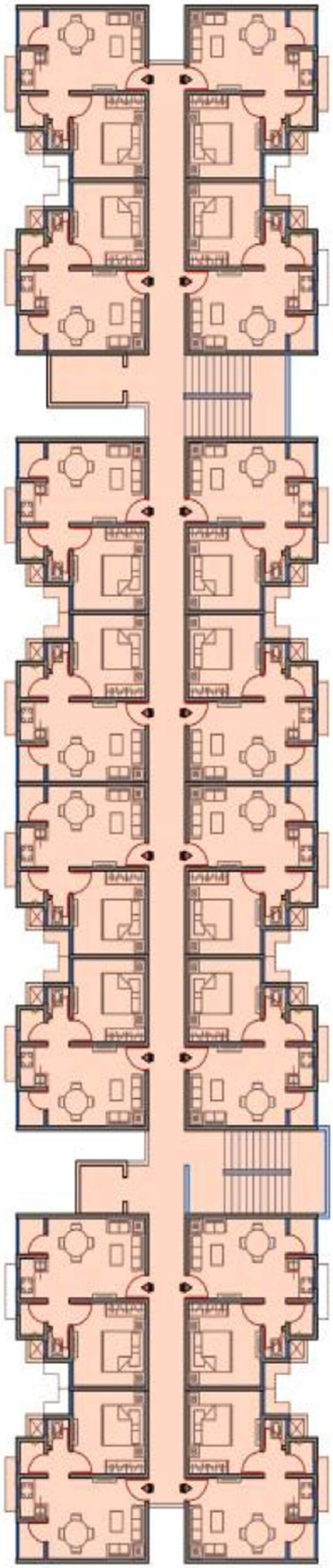


2.4.6 Floor Plans

Tower (E.W.S.)

Stilt + 13

(16 units on typical floor)



2.4.7 Physical Infrastructure Drawings

2.4.8 Social Infrastructure Building Drawings

2.5 LHP 5 Tamil Nadu

2.5.1 Location Map

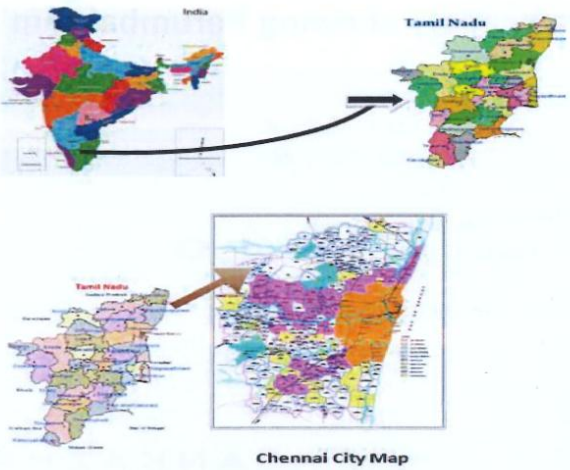


Figure 2.1 : Chennai Metropolitan Area Map

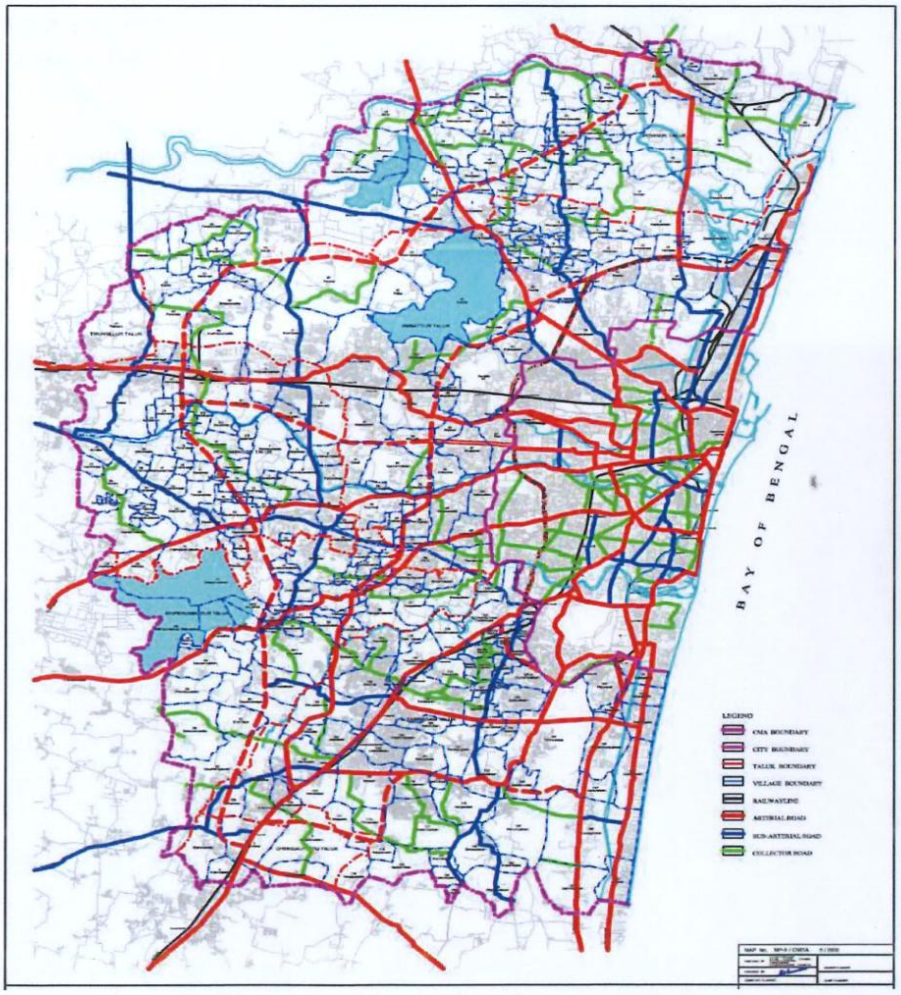


Figure 2.3 - Satellite Imagery showing Perumbakkam Scheme





3.1 LOCATION OF SITE

The Perumbakkam land is located in the Perumbakkam village, Sholinganallur Taluk, Kancheepuram District and adjacent to OMR – IT corridor in South Chennai.

The Perumbakkam land has been alienated with an extent of 81.20 hectares (200.65 Acres) Classified as "Tharisu" in favour of Tamil Nadu Slum Clearance Board for Construction of Multi-Storied building for Tsunami affected people vide G.O.(Ms) No.346, Dt: 14.08.2014 and G.O.(Ms) No. 186, Dt: 27.04.2015.

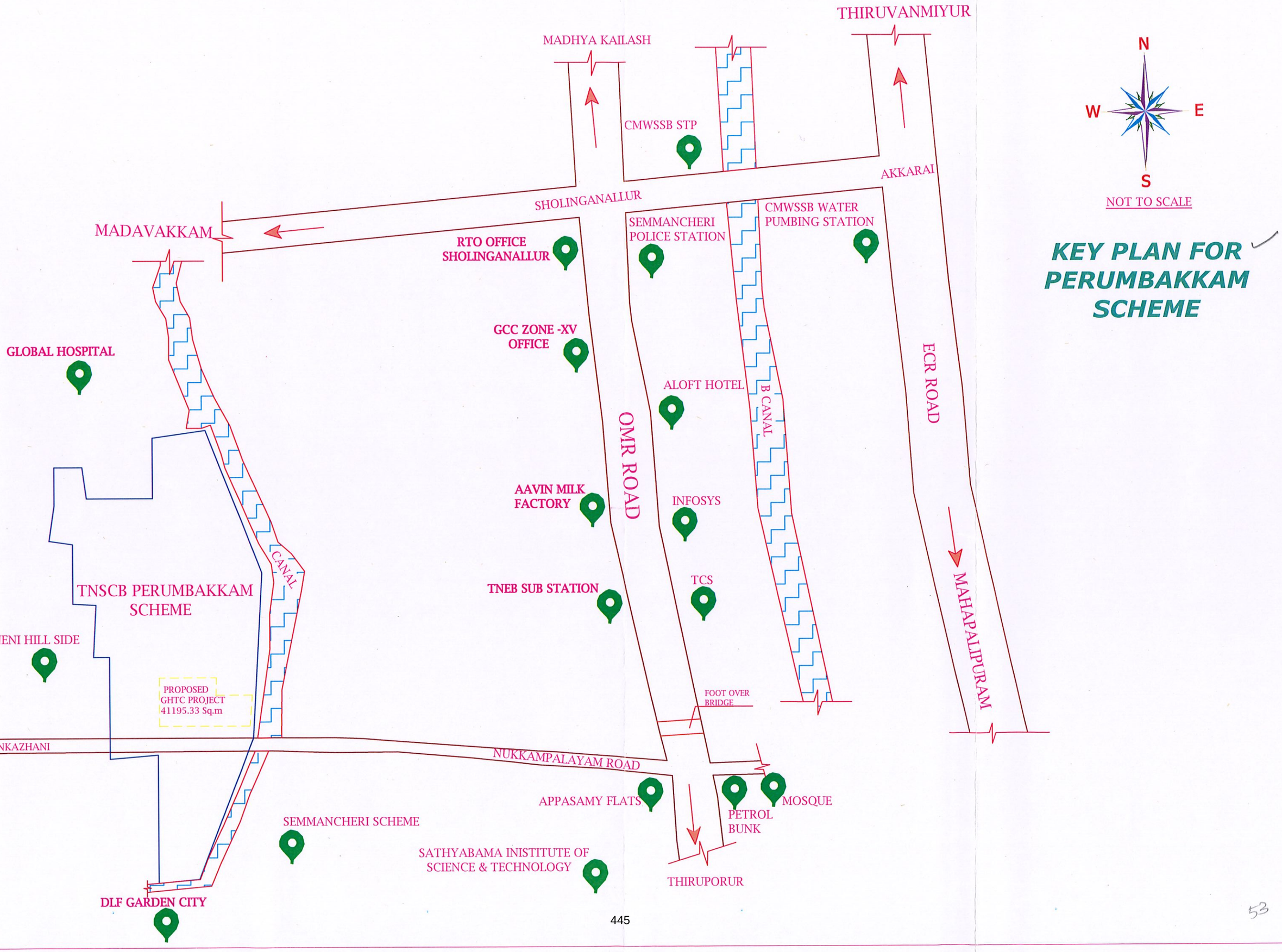
In this land, 20376 tenements were constructed under JNNURM and this land has been developed with infrastructure facilities such as Approach Road of 18m wide, Ration shops, Milk booth, Primary health centre, Community Hall, Government Arts and Science College, Government High School, Government Primary schools, ICDS Bus terminus cum Bus depot, 100 feet Road, Water supply, Underground drainage system with treatment plant, Street lights, Burial ground, Parks, etc.

A bit of land measuring an extent of 8.5 hectares is vacant and reserved for future development and still under possession of Tamil Nadu Slum Clearance Board. In this land an extent of 4.12 hectares has been proposed for Global Housing Technology Challenge –India, GHTC. This land will be more ideal for this project, since all infrastructure facilities are already available within the proposed scheme and also it is located at a distance of 2.20Km from the OMR Road where cluster of I.T. Parks and commercial complex, shopping malls, etc are existing.

SATELLITE IMAGE SHOWING TNSCB SCHEMES
PERUMBAKKAM



55



N
W
E
S

NOT TO SCALE

KEY PLAN FOR PERUMBAKKAM SCHEME

53

GOOGLE IMAGE SHOWING PERUMBAKKAM SCHEME FROM I.T.CORRIDOR



2.5.2 Total Station Survey Map

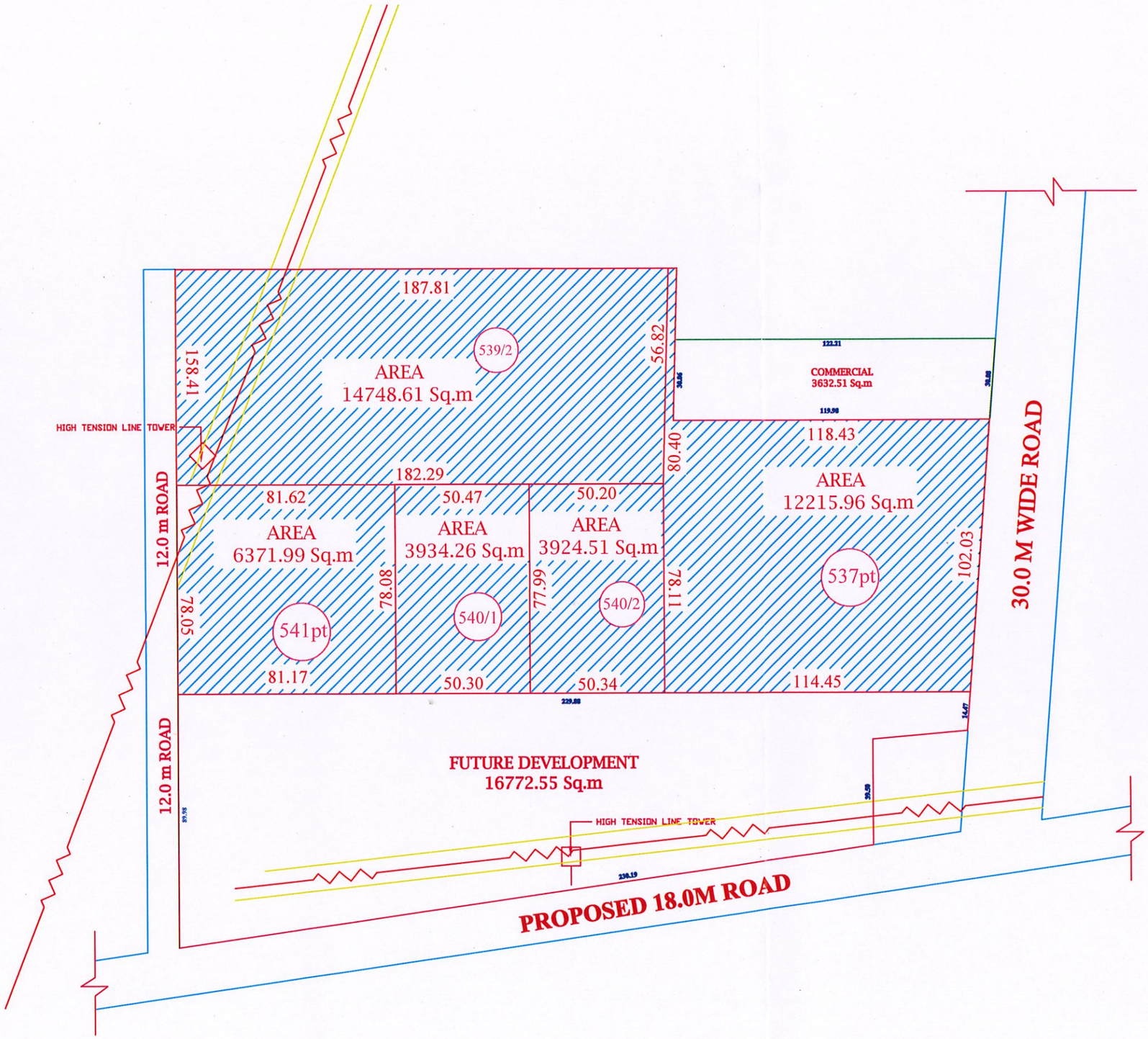
SURVEY SKETCH OF THE PROPOSED SITE WITH MEASUREMENT

TAMIL NADU
SLUM CLEARANCE BOARD

GLOBAL HOUSING TECHNOLOGY CHALLENGE:
NUKKAMPALAYAM ROAD, PERUMBAKKAM, CHENNAI IN S.NOS. 537, 539/1&2, 540/1, 540/2 & 541 PERUMBAKKAM VILLAGE, TAMBARAM TALUK, KANCHIPURAM DISTRICT.

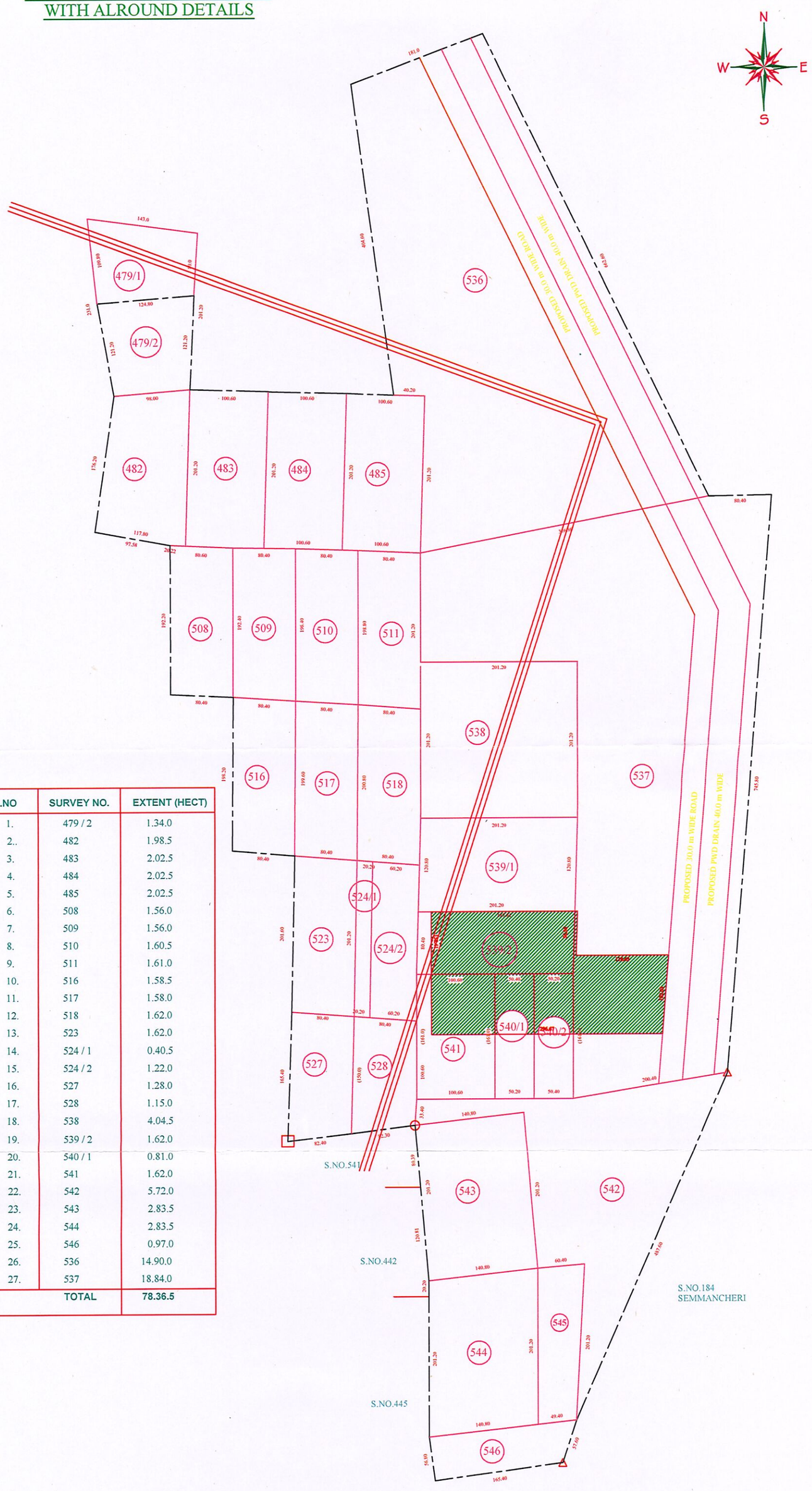
AREA STATEMENT:

S.No.539/2	- 14748.61 sq.m.
S.No.541pt	- 6371.99 sq.m.
S.No.540/1	- 3934.26 sq.m.
S.No.540/2	- 3924.51 sq.m.
S.No.537pt	- 12215.96 sq.m.
TOTAL AREA	- 41195.33 sq.m.



187

SURVEY SKETCH OF THE SITE WITH ALROUND DETAILS

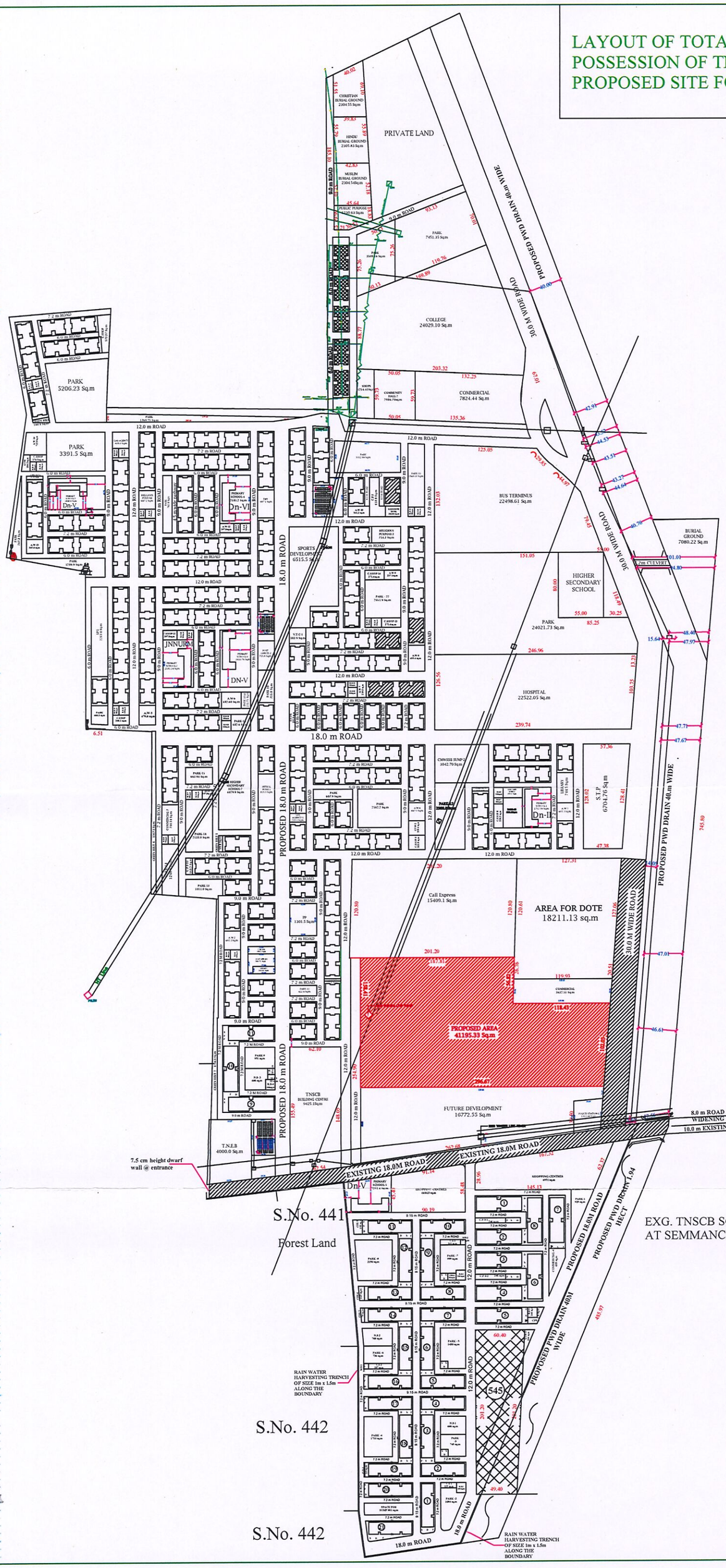


S.NO	SURVEY NO.	EXTENT (HECT)
1.	479 / 2	1.34.0
2..	482	1.98.5
3.	483	2.02.5
4.	484	2.02.5
5.	485	2.02.5
6.	508	1.56.0
7.	509	1.56.0
8.	510	1.60.5
9.	511	1.61.0
10.	516	1.58.5
11.	517	1.58.0
12.	518	1.62.0
13.	523	1.62.0
14.	524 / 1	0.40.5
15.	524 / 2	1.22.0
16.	527	1.28.0
17.	528	1.15.0
18.	538	4.04.5
19.	539 / 2	1.62.0
20.	540 / 1	0.81.0
21.	541	1.62.0
22.	542	5.72.0
23.	543	2.83.5
24.	544	2.83.5
25.	546	0.97.0
26.	536	14.90.0
27.	537	18.84.0
	TOTAL	78.36.5

449

129

LAYOUT OF TOTAL LAND UNDER POSSESSION OF TNSCB WITH PROPOSED SITE FOR GHTC-INDIA



TAMIL NADU SLUM CLEARANCE BOARD

PROPOSED PART LAYOUT FOR CONSTRUCTION OF MULTI-STOREYED TENEMENTS AT NUKKAMPALAYAM ROAD, PERUMBAKKAM, CHENNAI IN S.NOS.479/2, 482, 483, 484, 485, 508, 509, 510, 511, 516, 517, 518, 523, 524/1, 524/2, 536/1, 537, 538, 539/2, 540/1, 540/2 & 541 PERUMBAKKAM VILLAGE, TAMBARAM TALUK, KANCHIPURAM DISTRICT.

REFERENCE:

PERUMBAKKAM TYPE DESIGN

AS PER TYPE DESIGN - 7/2008 (G+7) (A)
PLINTH AREA - 36.22 sq.m
192 UNITS/BLOCK
11 x 186 = 2046
(GROUND FLOOR 6 UNITS USED FOR ELECTICAL AND OTHER AMENITIES)

EZHIL NAGAR TYPE DESIGN

AS PER TYPE DESIGN - 9/2008 (G+7) (B)
PLINTH AREA - 28.87 sq.m
192 UNITS / BLOCK
21 x 186 = 3906
(GROUND FLOOR 6 UNITS USED FOR ELECTICAL AND OTHER AMENITIES)

PERUMBAKKAM PHASE-II TYPE DESIGN

AS PER TYPE DESIGN - 7A/2008 (G+7) (C)
PLINTH AREA - 37.18 sq.m
96 UNITS / BLOCK
154 x 94 = 14476
(GROUND FLOOR 2 UNITS USED FOR ELECTICAL AND OTHER AMENITIES)

NAME OF THE SCHEME	NO. OF BLOCKS	NO. OF UNITS / FLOOR	TOTAL NO. OF UNITS	UNITS ALLOCATED FOR ELECTRICITY & OTHER AMENITIES	BALANCE NO OF DWELLING UNITS
PERUMBAKKAM	11	192	2112	66	2046
EZHIL NAGAR	21	192	4032	126	3906
PERUMBAKKAM PH-II	154	96	14784	462	14322
TOTAL	186		20928	654	20274

AREA STATEMENT

EXTENT (as per document)	- 81.20 HECT
EXTENT (as per patta)	- 81.20 HECT
EXTENT (as per site)	- 22.0715 HECT
DENSITY	- 348 / HECT
F.S.I	- 1.1026
PLOT COVERAGE	- 13.8%

FLOOR WISE AREA DETAILS:

NAME OF THE FLOOR	7/2008 (A) FSI AREA (sq.m)	7/2008 (A) NON FSI AREA (sq.m)	9/2008 (B) FSI AREA (sq.m)	9/2008 (B) NON FSI AREA (sq.m)	9/2008 (C) FSI AREA (sq.m)	9/2008 (C) NON FSI AREA (sq.m)
G. FLOOR	677.46	176.50	542.57	138.41	375.08	58.16
1st FLOOR	853.96	--	680.98	--	433.24	--
2nd FLOOR	853.96	--	680.98	--	433.24	--
3rd FLOOR	853.96	--	680.98	--	433.24	--
4th FLOOR	853.96	--	680.98	--	433.24	--
5th FLOOR	853.96	--	680.98	--	433.24	--
6th FLOOR	853.96	--	680.98	--	433.24	--
7th FLOOR	853.96	--	680.98	--	433.24	--

PARK AREA DETAILS:

EXISTING - 11466.0 sq.m (BELOW PROPOSED 18.0m ROAD-1)
PARK - 10 - 977.2 sq.m
PARK - 11 - 435.7 sq.m
PARK - 12 - 869.2 sq.m
PARK - 13 - 2988.3 sq.m
PARK - 14 - 607.9 sq.m
PARK - 15 - 1010.9 sq.m
PARK - 16 - 1265.5 sq.m
PARK - 17 - 663.9 sq.m
PARK - 18 - 31053.7 sq.m
PARK - 19 - 2051.9 sq.m
PARK - 20 - 845.8 sq.m
PARK - 21 - 714.3 sq.m
PARK - 22 - 2181.2 sq.m
PARK - 23 - 466.3 sq.m
PARK - 24 - 1289.9 sq.m
PARK - 25 - 746.3 sq.m
PARK - 26 - 3391.5 sq.m
PARK - 27 - 5206.2 sq.m
PARK - 28 - 1769.2 sq.m
PARK - 29 - 782.8 sq.m
PARK - 30 - 721.1 sq.m
PARK - 31 - 658.9 sq.m
PARK - 32 - 1138.3 sq.m
PARK - 33 - 3078.4 sq.m
G.B - 1 - 163.2 sq.m
G.B - 2 - 67.1sq.m
G.B - 3 - 87.0 sq.m
G.B - 4 - 1085.7 sq.m
G.B - 5 - 163.2 sq.m
G.B - 6 - 98.7 sq.m
G.B - 7 - 84.6 sq.m
G.B - 8 - 111.0 sq.m
TOTAL - 81200.1 sq.m
PARK AREA - 10.0%

LEGEND:

GHTC (PROPOSED LAND) - (41195.33sq.m)

NOTE:
- SUMP FOR SULLAGE WATER
- SUMP FOR FIRE FIGHTING WATER
- SUMP FOR DRINKING WATER
- SUMP FOR RAIN WATER COLLECTION

SCALE - 1:1200

PLANNING ASST.	PLANNING ASST.
SENIOR PLANNER	CHIEF ENGINEER

450

2.5.3 Soil Testing Report

REPORT ON SOIL INVESTIGATION AND RECOMMENDATION ON FOUNDATION FOR THE CONSTRUCTION OF STILT+8 STOREYED HIG FLATS AT ZONE 'H' OF PERUMBAKKAM PROJECT

Job No: SF/KI-49/ Perumbakkam/Zone 'H'/TNSCB/2013

Client: The Executive Engineer,
ETRP (C-II) Division, TNSCB
Semmenchery, Chennai-600 119.

S.No	Titles	Page.No
1.	Introduction	1
2.	Details of the project	4
3.	Preliminary Inspection of the project area	5
4.	Site condition	7
5.	Details of soil investigation	7
6.	Soil profile of the proposed site	9
7.	Block H1 to H4	10 to 15
8.	Ground water quality	19
9.	Summary	19
10.	Selection of foundation	21
11.	Recommendations	23
12.	Precautions	24
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14.	Figure 1 to 17	28 to 45
15.	Table 1 to 14	46 to 62
16.	Annexure G1 to G4	63 to 66
17.	Annexure U1 to U3	67 to 69
18.	Annexure C1 & C2	70 & 71
19.	Annexure CS1 to CS5	72 & 76
20.	Plate 1	77

Faculty of Civil Engineering
Anna University
Chennai – 600 025

Office : 2235 7544
2235 7546
Fax : 2220 0847

Dr. K. ILAMPARUTHI
Project Coordinator
&
Professor and Chairman (Civil)

REPORT ON SOIL INVESTIGATION AND RECOMMENDATION ON FOUNDATION FOR THE CONSTRUCTION OF STILT+8 STOREYED HIG FLATS AT ZONE 'H' OF PERUMBAKKAM PROJECT

Job No: SF/KI-49/ Perumbakkam/Zone 'H'/TNSCB/2013

Client: The Executive Engineer,
ETRP (C-II) Division, TNSCB
Semmenchery, Chennai-600 119.

1. Introduction

The Executive Engineer, ETRP (C II) Division of TNSCB has sent a request to conduct soil investigation in their housing project site at Perumbakkam TNSCB scheme area through Lr.No:203/E.C/ETRP CII/2012, dt: 03.01.2013 for the construction of MIG and FIG Flats. The Board proposed to construct residential flats in their housing scheme area as detailed below:

Sl.No	Detail	Number of blocks	Area of each unit (m^2)	Number of units
1.	MIG Flats (Stilt + 8 Floors)	12 (64 units in block each)	73.9	768
2.	FIG Flats (Stilt + 8 Floors)	4 (64 units in each block)	97.3	256

To construct these residential blocks an area of 7.13 Hectares is allotted covering survey Nos: 539/2, 540/1, 540/2 and part of 537. The area earmarked for the said purpose is shown in key map (Fig.1a) of the TNSCB Perumbakkam scheme. The proposal of the Board comprises of building nine storeyed (Stilt + 8 floors) framed structures. The Perumbakkam village is located at a distance of about a kilometer towards western direction from OMR. A road of 18m wide is connecting this village

of Civil Engg. Chennai-25

with OMR. On the southern side of this road and adjacent to existing TNSCB scheme at Semmencherry, the Executive Engineer (Div VI) of TNSCB executed similar project over an area of 30 Acres covering S.Nos: 542 to 544 during 2009. At this area eight storied framed structures were constructed and they are ready for occupation. These buildings are supported on raft foundation and the depth of foundation of all the buildings is around 4m. The Fig A1 shows the land allotted for the proposed construction including the area where project is completed.

On allocation of land by the Government The Executive Engineer (Div.II), TNSCB took initiative to implement the project and requested the services of Department of Civil Engineering to conduct Soil Investigation for the construction of Block 12 to 18 (S.No: 528) and constructions of Blocks covering area coming under S.Nos:479/2 and 482 to 485. These two locations are marked as Zone 'A 'and Zone 'B' in layout plan (Fig A1) and they lie in the south and north west part of the land allotted for the project.

At Zone 'A' investigation was conducted at 5 locations during April 2010. The top layer is expansive clay of 1.5m thick followed by clayey sand of 1m. Weathered rock was met at the depth of 2.75m invariably and fairly good rock was seen at depth around 4m. The water table was met at the depth of 2.5m. Based on the soil condition of the area, it was recommended to adopt raft foundation at the minimum depth of foundation of 3m (RL -1.45m).

At Zone 'B' investigation was carried out during the second week of June 2010 by drilling eight boreholes. The deposit of this area composed of highly plastic clay of 2m to 2.7m thick followed by residual soil (weathered rock reduced to soil) of 1m to 1.5m thick. However the deposit below 4.5m was fractured rock. At this area the water table was at the depth of 3m. The foundation recommended for the eight storeyed structures was raft foundation and minimum depth of foundation was 2.75m (i.e. RL -1.35m) from the lowest ground level. Recommended bearing capacity was 200kN/m^2. The board commenced the construction work at Zone 'A' and 'B' in the second week of May 2012.



In the remaining part of allotted land of Perumbakkam village, the Executive Engineer, JNNURM Division sent a request through Lr.No:171/JNNURM Dn/A1/2011, dt:28.3.2012 to inspect and conduct subsurface investigation covering survey nos: 509,510,511,516,517,518,536,537 & 538 for the construction of eight storeyed residential block in these location. Accordingly investigation was conducted at 40 locations covering 125 acres of land. Since the area was large, it was divided conveniently in to Zone 'C', Zone 'D', Zone 'E' and Zone 'F' as indicated in Fig A1.

The sub-surface investigation in all these areas was commenced on 25th April 2012 and completed on 19th May 2012. The report was released for each zone independently. The recommended foundation was raft for the eight storeyed buildings irrespective of the Zones in which buildings are proposed to locate. The recommended depth of foundation at different Zones is as below:

Zone	RL of Foundation (m)	Bearing capacity
C	between – 1.0m and -1.2m	220kN/m^2
D	between – -1.9m and -2.6m	220kN/m^2
E	between – -1.1m and -1.6m	220kN/m^2
F	between – 0.9m and -1.2m	220kN/m^2

Foundations of buildings were located at depths as recommended without difficulty except one or two blocks. As stated in the first paragraph of the report the board has drawn a proposal to construct MIG and HIG Flats in this area for the public, since the area lies within a distance of 2km from OMR and demand for house is more in this area.

The board has earmarked the area for this proposal, which lies in the south east part of the Perumbakkam scheme, which is about 7.13 Hectares. The project site was inspected along with the Executive Engineer of ETRP Division and other officials on 28.02.2013. Since the project area is large (total extent is 7.13 Hectares) the buildings are nine storeyed framed structure and this area comes under zone III as per IS1893-2002(Part-1), it is decided to investigate over entire area covering all the 16 blocks. At the end of investigation it is proposed to explore at two locations for each MIG block and at three locations for each HIG block. This proposal is been accepted by the Executive Engineer.

Dept. of Civil Engg. Anna University, Chennai-25.

Accordingly locations of boreholes for each block were selected and mutually agreed to investigate at 36 locations as detailed below:

Zone	Number of Blocks	Boreholes
M1	M1 to M6	BH1 to BH12
M2	M7 to M12	BH13 to BH24
H	H1 to H4	BH1 to BH12

Since large part of Perumbakkam Housing Project area was covered in earlier investigation and over all soil condition of this area is known to consultant. In this area, the hard stratum with good bearing resistance occurs within a depth of 4.5m; therefore it is felt sufficient to investigate to a depth of 9m. However one or two boreholes were drilled beyond the depth of 9m to know relative degree of weathering of rock deposit and its quality. The soil investigation work in all the three zones is commenced on 04.03.2013 simultaneously and completed on 9.4.2014.

2. Details of the project

The project to be executed in this area is construction of multi-storeyed blocks for the middle and high income group people under Rajiv Awas Yojana scheme. In this project the Board is proposed to construct 9 storeyed (Stilt + 8 Floors) framed structure by adopting two different type design; one is for MIG and the other is for HIG. Apart from construction of residential buildings they develop other amenities like club house, Gym, Park etc. However the soil investigation carried out is found mainly for the construction of multi-storeyed buildings. Each block of MIG is designed to accommodate eight families in each floor with plinth area of 73.9m^2/ family. Similarly the HIG flats are also designed to accommodate eight families in a block with plinth area of 97.3m^2/unit.

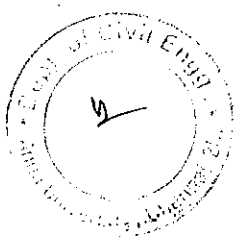
The structure is nine storeyed building and the area of construction is located within 20km distance from Chennai. The Chennai and its neighboring areas is coming under Zone III, hence the structure of this area is to be designed for Zone III conditions. Moreover in the recent past Chennai has experienced mild tremors and the earthquakes



occurred in Sumatra islands and Pondicherry coast also felt in some parts of Chennai. Therefore the board has analyzed the building for the Zone III condition. The minimum and maximum load at the foundation level for the critical load combination was reported as 869kN and 1890kN respectively. Since the soil is in the heterogeneous condition and in hard layer (i.e. weathered rock) clay lumps are seen during investigation, which is not conducive for isolated footing. Therefore the average load at the foundation level for the raft was obtained for the critical combination of load, which is 219kN/m^2.

3. Preliminary Inspection of the project area

Perumbakkam area has experienced fast development within a period of four years. The land of Perumbakkam area covering survey numbers as per the key plan (Fig. 1a) was occupied by the local people of the area. This entire area was covered with thatched roof houses, semi permanent and permanent buildings. The local town Panchayat laid temporary roads and provided water and power connections to the houses. Certain houses were provided with soak pits and were connected to toilets. These soak pits are 3.5 to 4m deep from the existing ground level. The area identified for the development of project is covered by 18m road on the south, compound wall of Bollini Hill Housing complex on the west, open private land on north and proposed PWD Drain of 40m wide on the east. This area is at a distance of approximately 2km from the OMR. The ground level of this area though it appears uniform, it is slopping from west to north east direction. The construction of multi-storeyed buildings in this project area was commenced during 2010 in Zone A and covered most part of the area part by part. The part of land, on the south east side of the area covering Survey Nos: 537, 539/2, 540/1, 504/2, 541 is vacant and is been identified for the construction of multi-storeyed flats. This area lies within the boundary of 18m wide Semencherry-Perumbakkam road on the south; 30m wide road and PWD drain are on the east, Zone D on north and community facilities of Zone A on the west. The total area is 71330m^2. The ground level of this area is almost uniform and is also free from shrubs and old structures; hence the site is ready for soil investigation. There is a mountain at a distance of about a kilometer or more on



the western side and the ground is slopping from the foot of the hill towards east. At the proposed construction site the ground level is the lowest while comparing with the ground level of neighboring areas. This area is prone for water logging hence the board is proposed to raise the existing ground level.

As stated in the introduction, the area of Perumbakkam (Zone A to Zone F) was already investigated at different pint of time for the purpose of locating suitable depth for foundation of eight storeyed structures and reported occurrence of hard stratum invariably at the depth below 4.5m and the weathered residual soil at depth of around 2.75m. The weathered residual soil was in hard/dense condition with N values more than 50 blows. However on the east and north east part of the area (Zone D) the deposit over a depth of 3m is soft. Keeping this in mind, it is proposed to investigate up to the depth of occurrence of hard stratum (N>100) at all the 36 boreholes. In a few boreholes rock drilling using single tube core barrel with diamond cutter is also recommended in order to confirm the presence of true hard stratum to a reasonable depth. The officials of TNSCB have agreed for this suggestion and proceeded accordingly.

Since the soil condition at major part of Perumbakkam project area is known from the earlier subsurface investigation carried out for the blocks at Zone 'A' to zone 'F' it is agreed mutually by the consultant and the officials of TNSCB to restrict the number of investigation points as minimum as possible. Since buildings are located as clusters accommodating other amenities for each cluster, it is decided to group at each cluster as individual zone. Thus there are three zones (M1,M2&H) and is mutually agreed to investigate at 12 points in each zone by distributing minimum of two exploratory points for each block. The subsurface investigation at the proposed construction area was commenced during the fourth week of February 2013. At all the borehole locations, the borehole was advanced using rotary drilling technique and standard penetration tests were conducted in each borehole at spacing of 0.75m using standard split spoon without liner as per IS2731-1972. The subsurface investigation work in this area was executed by M/s. Geotechnical solutions, Chennai under my (Prof.K.Ilamparuthi, Professor and Chairman,



Faculty of Civil Engineering) supervision. This report presents salient details of investigation and soil type encountered along with recommendation on foundation for the construction of HIG flats at Zone H.

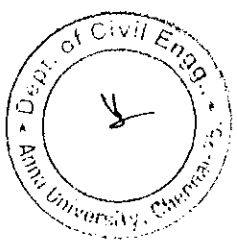
4. Site condition

The topography of Zone 'H' is almost uniform and if at all any difference in the levels within the area of investigation, which may not be more than 0.4m. The deposit on the surface exhibited honey comb pattern tension cracks, which confirm that the top soil is dominantly clay with shrink and swelling quality. Further there is a mountain at a distance about a kilometer or more from the western boundary of proposed construction area. It provides the clue that the rocky stratum will be at a shallow depth in the construction area and the soil cover that lies above is certainly residual deposit. However there is a chance for transported soil deposit on the surface since the ground is slopping from mountain on the west to canal on the east and the ground level is lower in this zone.

5. Details of soil investigation

At Zone 'H' it was proposed to construct four blocks. Soil investigation was carried out at three locations in each block and in total investigation was conducted at 12 locations as shown in Fig.1b. It can also be seen that the locations of various blocks in the figure. The details of borehole locations and the ground level at each location are presented below:

Bore hole No	Identification	Location	Ground level (RL)	Water Table (RL)
1	BH1	Block H1	+1.582m	+0.282m
2	BH2	Block H1	+1.312m	+0.112m
3	BH3	Block H1	+1.550m	+0.250m
4	BH4	Block H2	+1.280m	+0.180m
5	BH5	Block H2	+1.535m	+0.135m
6	BH6	Block H2	+1.592m	+0.192m
7	BH7	Block H3	+1.456m	+0.206m
8	BH8	Block H3	+1.376m	+0.176m
9	BH9	Block H3	+1.335m	+0.085m
10	BH10	Block H4	+1.210m	+0.210m
11	BH11	Block H4	+1.480m	+0.180m
12	BH12	Block H4	+1.500m	+0.300m



The boreholes were made to collect information on nature of overburden and depth of occurrence of hard stratum. They were drilled using rotary method with bentonite mud circulation. This method is normally adopted to advance the boreholes both in residual and sedimentary deposit. The circulation of drilling fluid was employed through drill rods and letting out through the jets provided in the cutting tool. The jetting action with pressure flow brings the cut material to the surface through the annular space between the sides of boreholes and drill rod. Boreholes of diameter 150mm were drilled by adopting this method. During drilling it was ensured that the borehole was kept full with drilling fluid to avoid disturbance to the sides as well as bottom heave. In the boreholes, standard penetration tests were conducted at required depth or wherever there was a change in the soil layer. This test was conducted using standard dimension split spoon without liner as per the procedure given in IS 2731-1972 using donut type hammer dropped mechanically (2 turns of rope in the cathead arrangement). The energy of impact was around 70%. Thus the field value was N_{70}. However the filed N values were corrected for the installation procedure and the value was very close to N_{60}. Therefore recorded values were taken as N_{60}. The values thus recorded were not corrected for overburden since the top soil to the depth of 2.5m was having fines more than 50%. Further the correction for saturation was also not applied for the resistance values recorded below water table since the deposit was not fine sand. Further the overburden correction factor is greater than unity for the N values recorded at shallow depths; hence the said conditions will certainly result in conservative resistance of deposit. The soil samples obtained from the split spoon were visually identified and tested in the laboratory for assessing index properties. Soil samples collected in split spoon samplers are subjected to test for index properties. The boring and sampling operations were continued at each location until refusal N value (rebound) was recorded or two consecutive N values were grater then 50 blows and the third N value was more than 100 blows. However at locations wherever rock was encountered, exploration was continued using single tube core barrel with diamond cutter. In the rock stratum drilling was done to a depth not less than 1m and obtained core samples. Attempt was also made to record water table in each borehole, after a time



lapse of 24 hours from the time of termination of investigation at each borehole location. The depth of ground water table recorded at various locations is included in the table presented in this section.

6. Soil profile of the proposed site

The investigation at this area was commenced after marking borehole locations and their reduced levels. The reduced levels of borehole locations are almost uniform at most of the locations except at BH6 and BH10. The difference in level is 0.4m between BH6 and BH10 and the RL at BH6 is +1.592m whereas at BH10 RL is +1.210m. However within a block the variation in ground level is marginal and not exceeding 0.3m. As stated in the previous section, the soil profile is logged at each location based on soil samples obtained using split spoon sampler. The profiles thus logged at 12 locations are presented in Figs 2 to 13 along with N values recorded. The field N values recorded are taken as $(N_1)_{60}$ (i.e. design N values) for the reasons already stated irrespective of the depth and nature of deposit of this area.

The disturbed samples of each borehole are tested for index properties inclusive of swell quality. The index properties such as Gradation, Atterberg limits, and Free Swell Index are presented in Table 1 to 12 for the boreholes BH1 to BH12. The gradation curves are presented in Annexure G. The undisturbed samples obtained from the clay layers are tested for strength. The strength is determined by conducting unconsolidated undrained test at their natural moisture contents on undisturbed samples of three boreholes and the respective stress-strain responses are present in Annexure-U along with Mohr-Coulomb envelope. The strength and secant modulus are also presented. The compressibility properties of clay deposits are also determined from the tests on UDS samples of BH1 and BH2 and presented in Annexure-C. The results include pre-consolidation pressure (P_c), Compression Ratio (CR) and Recompression Ratio (RR). The compressibility parameter, m_v is determined from index properties using established empirical relations between N and I_p. The m_v values thus obtained are presented in Table 13. The soil deposits logged at each block are presented and discussed below.

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Block H1

The block H1 is located on the northwest corner of the Zone H. At the block H1 three exploratory boreholes (BH1, BH2 &BH3) were made by locating two boreholes (BH1 & BH3) directly opposite to each other in the northeast and southeast corners of the block and the other on the middle of west side. At these three boreholes (BH1 to BH3) exploration was done to a depth of 9.3m, 8.5m and 8.0m respectively and the boreholes were terminated in severely jointed gneiss rock.

The difference in ground level at both the borehole locations is about 0.1m, which shows that the terrain is almost uniform at Block H1. The soil profile logged at BH1, BH2 and BH3 is presented in Fig 2, 3 and 4 respectively along with N values recorded.

At BH1 (Fig.2) the top layer to a depth of 2.4m is silty clay. This layer recorded a minimum N value of 2 blows at the depth of 0.75m and a maximum value of 14 blows at the depth of 1.8m. The top 1.4m clay layer is in soft consistency. Its stiffness is increased with depth and is in stiff condition between the depth 1.4m and 2.4m. Results of Atterberg limit tests show that this layer is high plastic clay (CH) and it possess volume change quality. Its liquid limit and plasticity index (Table 1) are more than 67% and 46% respectively. The strength and compressibility results of UDS of depth 1.5m show that C_u=29kN/m^2 and pre-consolidation pressure of 255kN/m^2 with over-consolidation ratio of 10. The over-consolidation ratio of 10 is attributed to desiccation. Despite over-consolidation the CR value is high, which is because of high moisture content in the sample. The deposit between the depth of 2.4m and 5.3m is a residual deposit. In this residual deposit, clay content is about 33% and is classified as SC. This intermediate layer is in dense condition and becomes very dense layer by recording N value > 100 blows. The rock is encountered at the depth of 5.3m, which is highly weathered and further exploration to depth of 9.3m confirms that the rock deposit is becoming strong. However the deposit at the depth of termination is severely jointed with core recovery ratio of 21%, which can be seen from the plate 1 wherein core samples obtained between the depth 7.3m and 9.3m are shown. Thus the deposit at BH1 within the depth of investigation of 9.3m is three layer system comprises of top layer of

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high plastic clay (CH), intermediate residual deposit of clayey sand (SC) followed by weathered rock. The weathered rock between the depth of 5.3m and 8.3m is calcareous sandstone and the rock is gneiss at the depth below 8.3m, which belongs to granitic family.

The BH2 which is been made at the middle of western side of block H1 has also recorded identical soil condition (three layer system) as that of BH1 within the depth of investigation of 8.5m. The soil profile logged is presented in Fig.3 along with resistance recorded. The top soil to a depth of 2.2m is silty clay. This layer is in soft condition at the depth of 0.75m and is becoming medium stiff at depth 1.5m. This layer contains plastic clay which is known from the plastic index values of the clay (I_p>48%). Its free swell index values are also more than 60% (Table 2). Thus the soil is clay of high plastic (CH) and is susceptible for volume change. The layer that follows the clay is clayey sand/silty sand with fines in the range of 22% to 25%. The N values recorded in this layer are more than70 blows, indicating that the layer is very dense condition. The deposit that lies below the depth of 4.8m is weathered rock; its degree of weathering appears to decrease, which is known from the recovery ratio of core samples. The recovery ratio of rock core between the depth of 5.5m and 6.5m is zero and between 6.5m and 8.5m is between 20% and 25% with nil RQD.

The test results of top layer (clay) and intermediate silty sand/clayey sand layer are represented in Table 2. From the test results it can be seen that the clay layer is highly plastic and susceptible for volume change due to seasonal moisture variation. The strength and compressibility test results of undisturbed sample also confirm that the clay deposit is soft and compressible than the clay at BH1.

The soil profile logged and test results on soil samples of BH3 are presented in Fig 4 and Table 3 respectively. At this location investigation was conducted up to the depth of 8.0m and the deposits were top layer of silty clay, intermediate layer of silty/clayey sand followed by weathered rock. The deposits encountered at this location are almost identical to that of other two locations of Block H1. The difference is only in their thickness. Top layer is clay of high plastic of 1.6m thick with I_p>49%. The layer that

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follows the clay is residual deposit of silty sand/clayey sand of 2.5m thick. It contains fines less than 15% and classified as SC/SW. The rock deposit between 6m and 8m is highly weathered gneiss with RQD of rock core 10%. Its uncondined compression strength this 7,000kN/m^2 (Annexure CS1)

Block H2

The Block H2 is located on the southern side of Block H1. In the location of Block H2 three boreholes (BH4&BH6) were made as shown in Fig.1b. BH4 was made on the southwest corner of the block. At BH4 exploration was terminated at the depth of 8.1m from the existing ground level. The ground levels at BH4 is +1.28mrespectively. The soil profile logged and N values recorded at these two borehole locations are presented in Fig 5.

At this borehole location top soil to a depth of 2.2m is silty clay with zero resistance. Its index test results are presented in Table 3. It has high liquid limit (between 67% and 85%) and plasticity index values between 45% and 62%, which indicates that the fines of this layer is plastic and the soil is classified as clay of high plastic (CH). The layer that lies below the silty clay layer is clayey sand/silty sand with fines less than 22%. Thickness of this layer is about 1.5m and is in dense (N>41) to very dense condition (N>100). There is a transition layer between top clay and residual silty sand, which is SC/CI. The weathered rock that lies below residual sand layer is highly weathered and fractured. However the presence of strong layer is confirmed by drilling to a depth of 8.1m at BH4, at which depth the deposit is severely jointed fractured rock, belongs to granitic gneiss. The core sample obtained from gneiss between the depth of 7.1m and 8.1m recorded RQD of 32%. Thus the rock mass is strong even though possessing vertical joints.

The soil profile logged at BH5 is presented in Fig 6. The test results conducted on samples of split spoon are presented in Table 5. Top layer is silty clay and its thickness is approximately 1.8m. In this clay layer liquid limit value is more than 65% and FSI



values are also more than 45%. These values confirm that the clay layer is active and is susceptible for volume change due to seasonal moisture variation. The N values recorded show that the clay layer is in very soft condition (N= 0).

The deposit between the depth 1.8m and 4.5m is residual clayey sand layer with fines between 20% and 27%. This layer is in dense (N=42) to very dense condition. The maximum N value recorded in this layer is 150 blows (extrapolated value) at 3.75m, which indicates that the stratum is becoming strong. At the borehole location weathered rock layer is met at depth approximately 4.5m and presence of rock deposit is confirmed by drilling to an additional depth of 3.5m. The borehole was terminated at the depth of 8.0m, at which the rock is granitic gneiss, which is jointed. The recovery ratio of core sample obtained between the depth of 7m and 8m is 48%. The RQD of sample is also 48%. Plate 1 presents the core samples of BH5. The core sample is tested for strength under unconfined condition. Its stress-strain response is presented in Annexure CS2. The peak strength of rock is 43,800kN/m^2.

The borehole 6 (BH6) is drilled at the northeast part of the block. The soil profile logged at this location is presented in Fig 7 along with N values recorded. At BH6 the top soil to a depth of 1.4m is silty clay, which is in soft condition (N$\leq$ 3). The deposit that follows the clay is silty sand of 3.4m thick. This sand deposit is in dense condition with N values greater than 45 blows. The deposit that follows silty/clayey sand layer is weathered rock which is highly weathered with RQD of zero. This weathered rock changes to strong (hard) rock at the depth of 7.2m and the core sample obtained between the depth of 7.2m and 8.2m recorded the recovery ratio of 32% and RQD of 20%. These values confirm that the rock occurring at depth below 7m is hard and is classified as gneiss. The strength of core sample is 10,400kN/m^2, which is far less than the core sample of BH5.

The laboratory test results of samples of clay layer and silty sand layer are presented in Table 6. The liquid and plastic limits of clay are in the range between 64% and 77% and 19% and 24% respectively. The samples also recorded FSI values more than 42%. Thus clay fines are active and plastic and the soil is classified as clay of high

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and intermediate plastic (CH). In the silty sand fines are in the range of 7% to 24% and sand fractions are more than 75% in deposit below the depth of 3m. Thus classified as clayey sand / silty sand (SC/SM).

Block H3

The block H3 is located on the eastern side of block H2 and the investigation was conducted at three locations by dispostining the boreholes in triangular pattern as in Fig 1b. Two boreholes are in the northwest (BH7) and north east (BH9) corners and the third borehole is made at the centre of south side of the block. At BH7 exploration was made to a depth of 8.1m and was terminated in grayish jointed hard rock (gneiss). The deposit at this borehole location comprises of soft clay layer of 1.9m thick followed by stiff clayey sand layer of 0.6m thick. The N value recorded in the clay layer is between 2 and 4 blows. In the sand layer the resistance is high (N>38) and recorded refusal condition at the depth of 5.1m. The rock that follows the clayey sand is highly weathered and fractured wherein recovery ratio is nil between the depth of 5.1m and 6.1m. However the degree of weathering is reduced with depth, which is confirmed from the recovery ratio and RQD values. The RQD of core sample is 23% (Plate 1) for the deposit between the depth of 7.1m and 8.1m.

The soil profile logged at BH8 (Fig.9) is almost identical to that of BH7. Top layer is soft clay of 1.8m thick with N value 3. This layer is underlain by stiff clay of 1.1m thick with N value of 12 blows. The deposit that follows the stiff silty clay is residual clayey sand layer, which is hard to very dense condition. Thickness of this layer is 2.1m and its fine fraction is less than 15%. It is becoming very strong by recording N value >100 at depth below 3.75m. The refusal condition is encountered at 5.0m depth where the deposit is highly weathered rock. This layer continues up to 8m at which depth the borehole was terminated. The core samples extracted at various depths of this borehole recorded minimum core recovery of zero and maximum core recovery of 58%. The rock available between the depth 5.0m and 7.0m is weak whereas at depth between 7m and 8m is strong with RQD of 58%. However the deposit below the depth of 5.0m



can be considered as strong bearing layer. The laboratory test results of top clay layer are presented in Table 9. The liquid and plasticity index values are high and its plasticity indices are between 41% and 47%. Free swell index of the clay is between 66% and 100%. Thus the clay layer of BH8 is high plastic clay with swelling clay minerals. It is classified as clay of high plastic (CH). The rock sample is also tested for strength and its stress-strain response is presented in Annexure CS4. The peak strength of rock under unconfined condition is 26,300kN/m^2.

The deposits encountered at BH9 are logged and presented in Fig.10 along with N values recorded. The deposits of this borehole location are almost identical that of BH7 except marginal variation in thickness. The top layer is clay of high plastic (Table 9) as seen at BH7, but its thickness is 2.1m. However the clay layer has almost identical character as that seen in the clay of BH7. The second layer is clayey sand/silty sand, its thickness is about 2.4m and is in hard condition and becomes very dense (N>100) at the depth of 3m. The deposit that follows the sand layer is weathered fractured rock and recorded refusal N value at the depth of 4.5m. This stratum continues up to 7.8m, at which depth, the borehole was terminated. The rock deposit available at depth between 5.8m and 6.8m is moderately strong but weathered since recovery ratio and RQD values are 26% and zero respectively.

Block H4

At Block H4, exploration was done at three locations as shown in Fig.1b. Borehole 10 (BH10) and borehole 12 (BH12) are located directly opposite to each other and borehole 11 (BH11) is drilled at the middle of western face of the block. At BH10 the deposits are soft silty clay followed by silty clayey sand up to 3.6m from the existing ground level followed by weathered rock up to 5.3m, at which depth; the borehole was terminated (Fig 11). The clay layer is in soft condition with N value of 2 blows. This layer is classified as clay of high plastic (CH) since liquid and plasticity index values are more than 56% and 38% respectively. The sand layer that follows the clay is classified as clayey sand in which fines are about 30% and sand fractions are more than 60% (Table

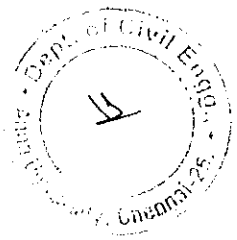
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10). It is in very dense condition with N value much higher than 100 blows at depth below 3m. The rock layer that lies below the clayey sand is highly weathered till the depth of 5.3m. However the degree of weathering in rock layer is reduced with depth and core recovery of 14% is obtained in the rock between the depth of 4.3m and 5.3m. The occurrence of hard stratum at this borehole is at shallow depth from the ground level (RL +1.210m) when compared to other locations of the Zone H.

The deposit encountered at BH11 and BH12 are presented in Figs 12 and 13. At both the locations the top layer is soft clay with negligible strength (N=0) and its thickness is approximately 2.6m. The thickness of residual soil is about 1m only at these boreholes and weathered rock occurs at depth of 3.5m, which occurs almost at uniform level in the area of block H4. The borehole 11 was terminated at the depth of 6.4m, where the deposit was jointed gneiss rock. The recovery ratios of core samples obtained in this deposit was 26% and RQD=14%. At BH12 exploration was terminated at 7.5m at which depth the deposit was severely jointed weathered rock. The recovery ratio of core samples in 15% and 18% for the deposit between 5.5m and 7.5m. The clay layer possesses characteristics as that of clay of intermediate to high plastic (Table 11). The rock layer that lies below the sand is highly weathered but strong bearing layer. The degree of weathering is reduced with depth and the strength of rock between the depth of 5.4m and 6.4m at BH11 is 31,700kN/m^2.

The overall variation of deposits at locations of each block are combined and presented in Fig 13 to 16 for blocks H1 to H4 respectively. From the figures presented and properties given in tables it is clear that the deposit of the area within the depth of investigation comprises of three layer system. The top layer is clay of high plastic (CH) with liquid limit higher than 60% in general. The swelling quality of the clay is critical to high and is confirmed through the free swell index values more than 60% in most of the samples. Its thickness is found to vary between 1.9m and 2.7m and is in soft condition at most of the locations. The soil of this layer is not even suitable for filling work.

The deposit that lies below the clay layer (CH layer) is clayey sand/silty sand. Its maximum thickness is about 3m. This layer is in dense condition with recorded N values



are close to 50 blows or more except at the transition zone between clay and sand layers. The limitation in this layer is presence of clay lumps and, clay patches at certain locations. These lumps are part of highly weathered soil derived from the parent material rock. As long as clayey sand layer is intact there may not be change in their property but due to release in pressure and direct contact with water it will become soft. Thus the condition is not favorable for isolated footing. Moreover excavation of this layer in presence of water or below the water table will create a problem to locate the foundation in this layer provided the water table is reduced well below so that the soil is not losing its strength and provides good environment for construction.

The third layer is weathered rock. In this deposit degree of weathering is decreasing with depth and the thickness of strongly weathered portion is around one meter. The recovery ratio of rock generally less than 10%in weathered layer of the rock and in most of the locations the RQD is nil. The rock stratum at depth below 6.0m is strong deposit however it is, fractured and severely jointed. This rock mass recorded maximum recovery ratio of 58% at BH8 and the RQD is 56%. The rock cores obtained from the boreholes are shown in Plate 1. Rock samples of certain boreholes are tested for strength under unconfined condition and test results are presented in Annexure CS1 to CS5. The unconfined strength of samples is presented below along with secant modulus of samples. The strength of rock found to vary widely, the minimum and maximum strength values are 7000kN/m^2 and 43,800kN/m^2 respectively. The high value is in granitic rock of BH5 at the depth between 7.0 and 8.0m. The RQD of sample tested for strength is 48%. The strength of rock of Zone H is higher than the strength of rock deposit of Zone M2.

S.NO:	Identification	Depth, (m)	Unconfined Strength, (kN/m^2)	Secant Modulus (kN/m^2)
1.	BH3	7.0-8.0	7000	169200
2.	BH5	7.0-8.0	43800	413200
3.	BH6	7.2-8.2	10400	336400
4.	BH8	7.0-8.0	26300	359500
5.	BH11	5.4-6.4	31700	353000



The properties of various soil layers both strength and compressibility are obtained from the N values using existing correlations and presented in Table 13. In case of clay Terzaghis' relation is used for obtaining undrained cohesion (C_u) values. The values thus obtained are found to vary between 10kN/m^2 and 20kN/m^2 in soft clay and the values are in the range between 30kN/m^2 and 70kN/m^2 in medium stiff to stiff clay. The strength obtained from UCC test on undisturbed samples is 9kN/m^2 and 17kN/m^2, which are in comparison with the values obtained by empirical correlation. In silty sand/clayey sand angle of shearing resistance (ϕ) is obtained using Meyerhof recommendations. However the modification suggested by Houch for the percentage fines present in the deposit is applied. The ϕ values obtained are varying between 32° and 42°.

In sand compressibility parameter is obtained by the relation $C=1.9\ q_c/\sigma'_0$, where q_c–cone resistance and σ'_0–effective overburden pressure. This procedure was developed by DeBeer and Martens (1957) and later on modified by Meyerhof to determine the elastic settlement in non plastic cohesionless deposit. IS 8009 (Part I), is also recommends this method to obtain immediate settlement. In the absence of cone resistance (q_c), it is considered equal to 240N to 300N (kN/m^2) since the deposit is SC/SM type. The strength and compressibility parameters thus obtained are summarized in Table 13.

In the absence of consolidation test results on samples of certain boreholes, the compressibility parameter, m_v (=1/E) of clay deposit of Zone H is obtained from the chart of Stroud (1975) which accounts for the plasticity of clay fines and the value is based on N_{60} value and is equal to 1/F N_{60} (m^2/kN). The "F" is varying between 420 and 480 in medium to stiff clays. However the compression test results on UDS of certain boreholes confirm that the clay deposit is preconsolidated, and overconsolidation ratio of tested samples are between 3 and 10. The shear strength of rock is obtained from the UCC tests conducted on core samples and the values are in the range between 7,000kN/m^2 and 43,800kN/m^2 respectively. The C_u values are also obtained for highly weathered rock based on Cole and Stroud (1977) chart and the values thus obtained are presented in Table 13.



7. Ground water quality

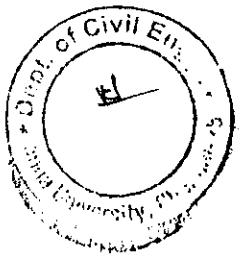
The ground water table at all the boreholes is monitored and the levels are reported in section 5. Water samples are collected and tested for pH, sulphates and chlorides. Since the water is brackish, it is also decided to test the soil for above properties. The chemical test results are presented Table 14:

In water samples tested, pH is in the range between 7.35 and 8.25 and can be said that water is neither acidic nor alkaline. The chlorides and sulphates are very high and the amount of chlorides present in ground water indicates that the ground water of this area is just like sea water.

In soil, the contents of sulphates and chlorides are more in clay layer within the depth of 1.5m. The soil is alkaline at BH12 and rest of the tested locations it is close to neutral condition. It also contains both sulphates and chlorides and they are more than 300ppm and 2100ppm respectively except in soil depth of 1.5m in borehole H1. The results of tests on soil and water are to be reconfirmed. Sulphates and chlorides both in soil and water are more than the permissible limits as per IS 456 (Refer Table 4). Since ground water is very poor in quality suitable measure is to be taken to protect concrete and rebars from sulphate attack and corrosion of reinforcement. The clayey soil is not only plastic but also contains chlorides and sulphates in high quantity, hence not suitable for filling.

8. Summary

1. The top soil is highly plastic clay at all the borehole locations. Its thickness is found to vary between 1.9m and 2.7 m. It is susceptible for volume change due to seasonal variation in the moisture content. Free swell index value is as high as 100% at a few locations indicating clay is active. It is in medium stiff to stiff condition at certain depth and at most of the locations the clay is in soft state. Native clay soil is not at all suitable for any construction work including back fill of basement and foundations.



2. The deposit below the depth of 2.7m from the existing ground level is residual deposit (highly weathered rock), which is a strong layer. The minimum N value recorded in this layer is 27 blows, which indicates that the deposit is in medium dense state. Further fines are less than 25% in sand at most of the location except at the transition zone between clay and sand and the balance content is dominantly sand and gravel fractions. This layer is strong enough to support any shallow foundation. However presence of clay lumps and clay patches need to be considered while deciding the foundation type.
3. The deposit below 5.5m is highly fractured rock which has recorded refusal N value. The recovery ratio of rock samples found to vary between 0 and 20% at most of the depths of rock deposit, which indicates that the rock is jointed and fractured. However a value of 58% is also recorded at certain depth of rock deposit. RQD is generally zero and more than 20% is recorded in rock samples obtained at depth below 7m at five boreholes located in Blocks H2 and H4. The maximum RQD is 56%, which is recorded in BH8 at the depth between 7.0m and 8.0m.
4. The water table level is at shallow depth (1m to1.4m) from the existing ground level. The lowest level of ground water table is +0.085m (RL) at the time of investigation (March 2013). The sulphates and chlorides are present in both soil and water samples.

From the summary presented it is evident that the deposit of area is suitable for providing foundation at shallow depth. However the top soil to a depth of 3.0m is not good particularly in the southwest region of Zone H; hence foundation cannot be located within the depth of 3m. Therefore it is felt essential to locate the foundation at a minimum depth of 3.2 from the existing ground level. The depth suitable to locate the foundation is 3.2m or below from the existing ground level. The maximum variation in the reduced level of borehole locations is about 0.4m (maximum + 1.592m and minimum +1.210m); hence minimum level of foundation shall be -2.0m



(RL). However depth of foundation for each block of Zone H area is given in the Section 10.

9. Selection of foundation

The subsurface condition of deposit of area is very much suitable for shallow foundation except that the foundation needs to be taken below the top clay layer. In this case it is suggested to locate the foundation at a minimum depth of 3.2m from the existing ground level. In order to decide the depth of foundation of the blocks, N value more than 50 blows and location of water table are compared as below:

Borehole No:	Block No:	RL of stratum at N>50, (m)	RL of min.Depth of foundation, (m)	WT RL, (m)	Remarks
BH1	H1	-2.068	-1.920	+0.282m	Water table is above the foundation level
BH2	H1	-1.388	-1.490	+0.112m	Water table is above the foundation level
BH3	H1	-1.05	-1.250	+0.250m	Water table is above the foundation level
BH4	H2	-1.870	-1.720	+0.180m	Water table is above the foundation level
BH5	H2	-1.615	-1.215	+0.135m	Water table is above the foundation level
BH6	H2	-1.558	-1.608	+0.192m	Water table is above the foundation level
BH7	H3	-1.694	-1.744	+0.206m	Water table is above the foundation level
BH8	H3	-1.774	-1.824	+0.176m	Water table is above the foundation level
BH9	H3	-1.665	-1.865	+0.085m	Water table is above the foundation level
BH10	H4	-1.790	-1.990	+0.210m	Water table is above the foundation level
BH11	H4	-1.920	-1.920	+0.180m	Water table is above the foundation level
BH12	H4	-1.400	-1.400	+0.300m	Water table is above the foundation level

From the comparison made it is clear that foundations are to be located below the water table. The water table level reported is obtained from the borehole during

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investigation; there is a possibility for variation in the water table level. Therefore it is suggested to ascertain the water table level at each block at least at two corners before proceeding with the work of foundation. Normally the actual water level may be higher than that recorded in the boreholes. It is suggested to locate the foundation a few centimeters above the water level in order to avoid excavation below the water table otherwise excavation below water table makes the soil to lose its strength. However at Zone H area the foundations are to be located below the water table, hence dewatering is essential.

The bearing capacity and settlement of foundation for the minimum depth of foundation given in the table are determined. The bearing capacity is determined for the raft foundation of size 23mx46m (approximate) using Teng (1961) equation and bearing capacity equation given in IS6403. The allowable bearing pressure is obtained for 25mm settlement using Teng equation and it varies between 306kN/m^2 and 368kN/m^2 for the N values of 35 and 42 respectively. The net safe bearing capacity value obtained from IS6403 for ϕ=36° is 1300kN/m^2 for FS=3. The soil at the foundation level of certain boreholes is stiff sandy clay with fines around 25%. Though thickness of sandy clay layer is less the bearing capacity value is determined by considering the lowest N value of 35 is 306kN/m^2 for a settlement of 25mm. Thus it is sure that the soils at the foundation levels are having good bearing strength and more over raft foundation of large size will provide higher bearing resistance and the settlement is real concern. The recommended bearing capacity is 250kN/m^2. The bearing capacity is reduced from the minimum value of 306kN/m^2 obtained, in order to account for the undesirable condition like presence of clay pockets. The average load intensity expected at the foundation level for the combination of load may not exceed 220kN/m^2, which is close to the bearing capacity recommended. The shallow foundation like isolated footing is not considered because of heterogeneous nature of soil (week zones like clay patches and clay lumps). However as an academic exercise the capacity was worked for the isolated footing of 2.5mx2.5m for the ϕ'=36°. The net safe bearing capacity obtained is 190kN/m^2, which is less than the expected average pressure of 220kN/m^2 of raft foundation. However the

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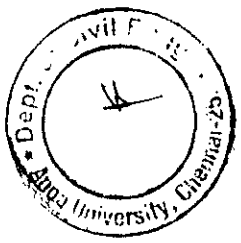
contact pressure expected will be more than 190kN/m^2 if isolated footing is proposed to adopt for each column. If the bearing capacity is limited to 190kN/m^2 then foundations of columns are to be combined. Thus only option to support stilt+eight storeyed buildings in the Zone 'H' of Perumbakkam project is raft foundation

The settlement of raft foundation is also worked out for the soil conditions of individual borehole for the net pressure of 250kN/m^2. The foundation is supported in silty sand / clayey sand layer which is non-plastic with course fractions around 70% followed by weathered/fractured rock. Therefore elastic settlement of foundation is obtained using DeBeer and Martens (1957) equation. The elastic settlement obtained at various locations is less than 25mm for the contact pressure of 250kN/m^2. Thus the raft foundation is the ideal choice for supporting the foundations of proposed stilt + eight storeyed blocks H1 to H4 at Zone 'H'.

The one more issue is depth of foundation of each block can be different because of variation in depth of occurrence of bearing stratum within the Zone H. The occurrence of bearing stratum within a block itself is varying, therefore among the minimum level of foundation referred in the above table for a given block, the lowest level is considered as a suitable foundation level. The minimum depth of foundation (RL) required at various blocks is varying between -1.8m and -2.0m. In this area the water table level at boreholes is found to vary between +0.28m and +0.085m, and is above the recommended level of foundation, hence interference of water table cannot be avoided while executing the earthwork excavation to reach proposed level of foundation. The foundation excavation in presence of water is to be avoided. Adopt suitable dewatering method to lower the level of water table at least to a level of 0.5m below the foundation level.

10. Recommendations

The subsurface exploration conducted confirms presence of good bearing stratum at a depth of 3.2m at most of the area of Zone H. Thus occurrence of good bearing stratum is at shallow depth and it occurs more or less at uniform depth. Further the deposit at the depth below 5.5m over the entire area of Zone H is certainly weathered rock. The top



layer is soft at most of the locations and at locations wherever clay is medium stiff to stiff possesses volume change characteristics. This layer will exhibit high swelling (DFS>100%). Thus it is recommended to locate the foundation at a minimum depth of 3.2m from the lowest ground level, thus foundation level is varying between -1.9m and -2.0m (RL). However it is proposed to adopt uniform foundation level of -2.0m for all the four blocks, since the difference in level is marginal. For the structure of stilt + 8 storeyed building it is recommended to support the structure on a raft foundation. The recommended bearing capacity of soil for the raft foundation of 23m x 46m (approximate size) is 250kN/m^2. Though the soil below the depth of foundation possesses higher bearing strength, it is advised not to exceed the value of 250kN/m^2 because of non-homogenous nature of the deposit. Recommended level of foundation for the blocks H1 to H4 is as below:

Sl.No:	Block	Reduced level of Foundation,(m)
1	H1	-2.0
2	H2	-2.0
3	H3	-2.0
4	H4	-2.0

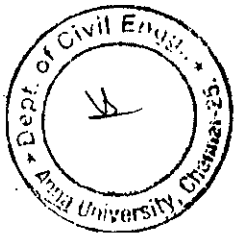
The level of foundation refers to base of a raft and the raft shall be laid on leveling course followed by sand cushion of adequate thickness each as per the practice in the board.

11. Precautions

1. The top soil to the depth of 2.0m is poor and highly swelling (expansive) hence does not suitable for any construction or filling work.
2. The maximum depth of occurrence of water table in zone H is +0.30m (RL) and the soil at this depth is clayey at most of the location hence excavation under this condition without dewatering will lead to collapse of cut and also reduction in strength of soil because of seepage through the bearing stratum.



3. Earth work excavation particularly below the water table to be allowed unless the water level is lowered to minimum depth of 0.5m from the recommended level of foundation. Adopt suitable scientific method for dewatering.
4. The depth of foundation recommended for each block is minimum depth of foundation. There may be chances for variation in foundation depth because of uncertainty in the characteristics of highly weathered residual deposit in the Zone H area. Improper dewatering and submergence of weathered soil may lead to significant reduction in strength, which may demand foundation at deeper depth than recommended to realize bearing capacity of 250kN/m^2. Do not reduce the foundation depth without obtaining proper approval from the consultant in case of good bearing stratum is met at higher level than the recommended level of foundation.
5. The water table in this area is at shallow depth. The seepage of water at the interface of weathered rock and soil cover will be critical hence conduct a pilot study to determine seepage parameters of deposits and to design suitable dewatering system. Technical support required for designing the dewatering system will be provided if required by the client. No case seepage is permitted directly through the foundation soil i.e. seepage of water shall be away from the excavation area (i.e. foundation area) and not towards the excavation area.
6. The quality of ground water is not suitable for any construction work especially for foundation construction. Since the environment of both ground water and soil is aggressive, this will lead to sulphate attack on concrete and corrosion of reinforcement. The concrete and steel need to be protected from the aggressive action. Thus provide minimum cover of 75mm in addition to any other protective measures considered suitable. Obtain opinion from structural consultant for protecting foundation elements and part of columns and beams buried below the ground. Further the cement quality and the content shall satisfy the requirement of Table 4 of IS 456-2000.
7. Since the ground water is not satisfying the requirement, use good water for all concrete related work. Minimum grade of concrete recommended for the foundation



work is M25. Follow the conditions relevant to quality of water for concrete work as per IS 456-2000 including minimum cover thickness.

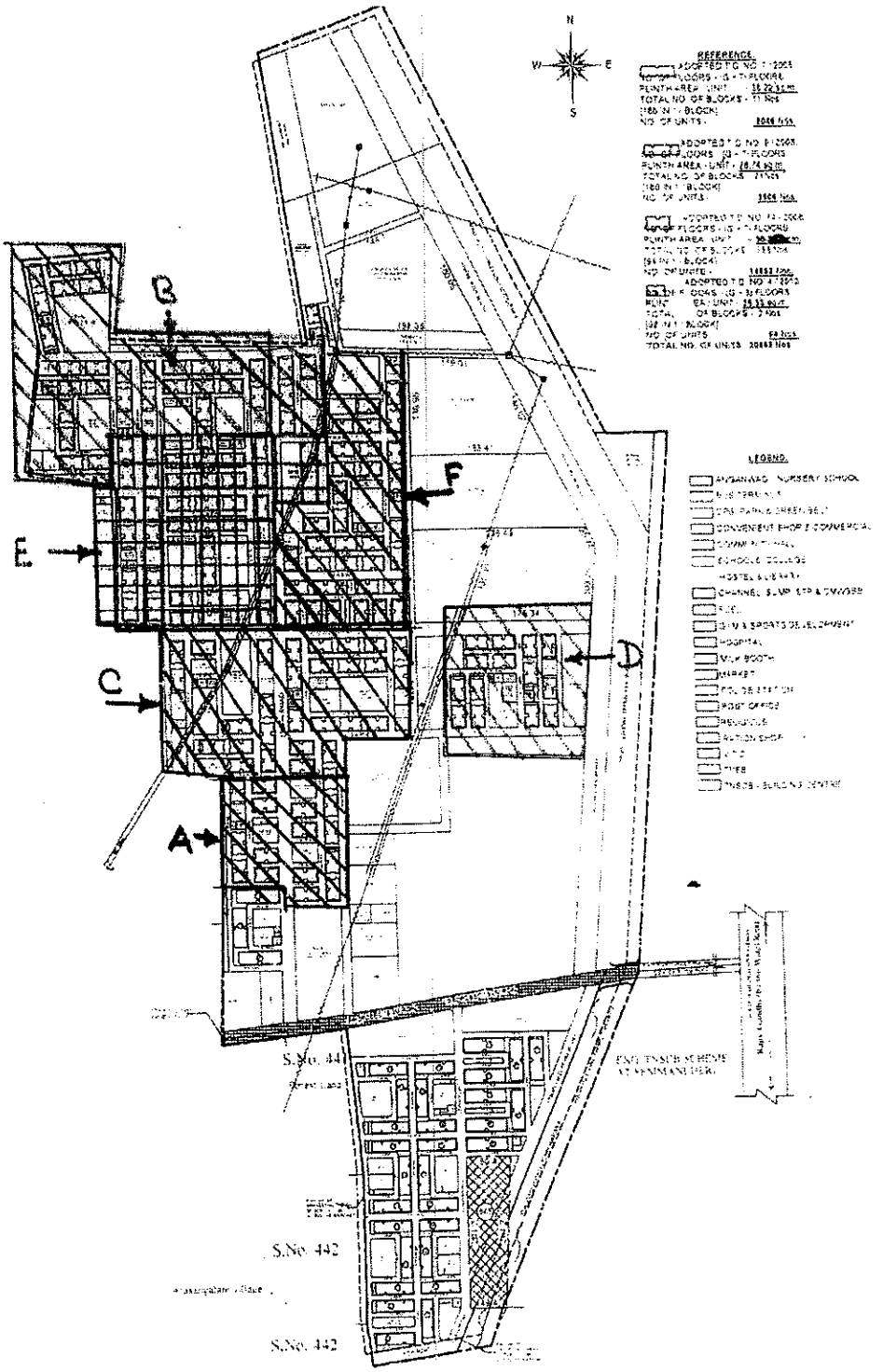
8. For filling works both inside the basement and outside around the building use good earth. The native soil particularly the high plastic clay is not at all suitable for any construction work including basement filling.
9. The basement filling will be more than 3.0m hence conventional flooring for the ground storey may lead to settlement problem on later days. It is suggested to provide RCC floor for ground floor base slab.
10. In case of any variation observed from the soil profile reported while execution of foundation work, bring it to the notice of consultant immediately for suitable advice. Do not change the recommended level of foundation without the knowledge of foundation consultant.

30/7/2014

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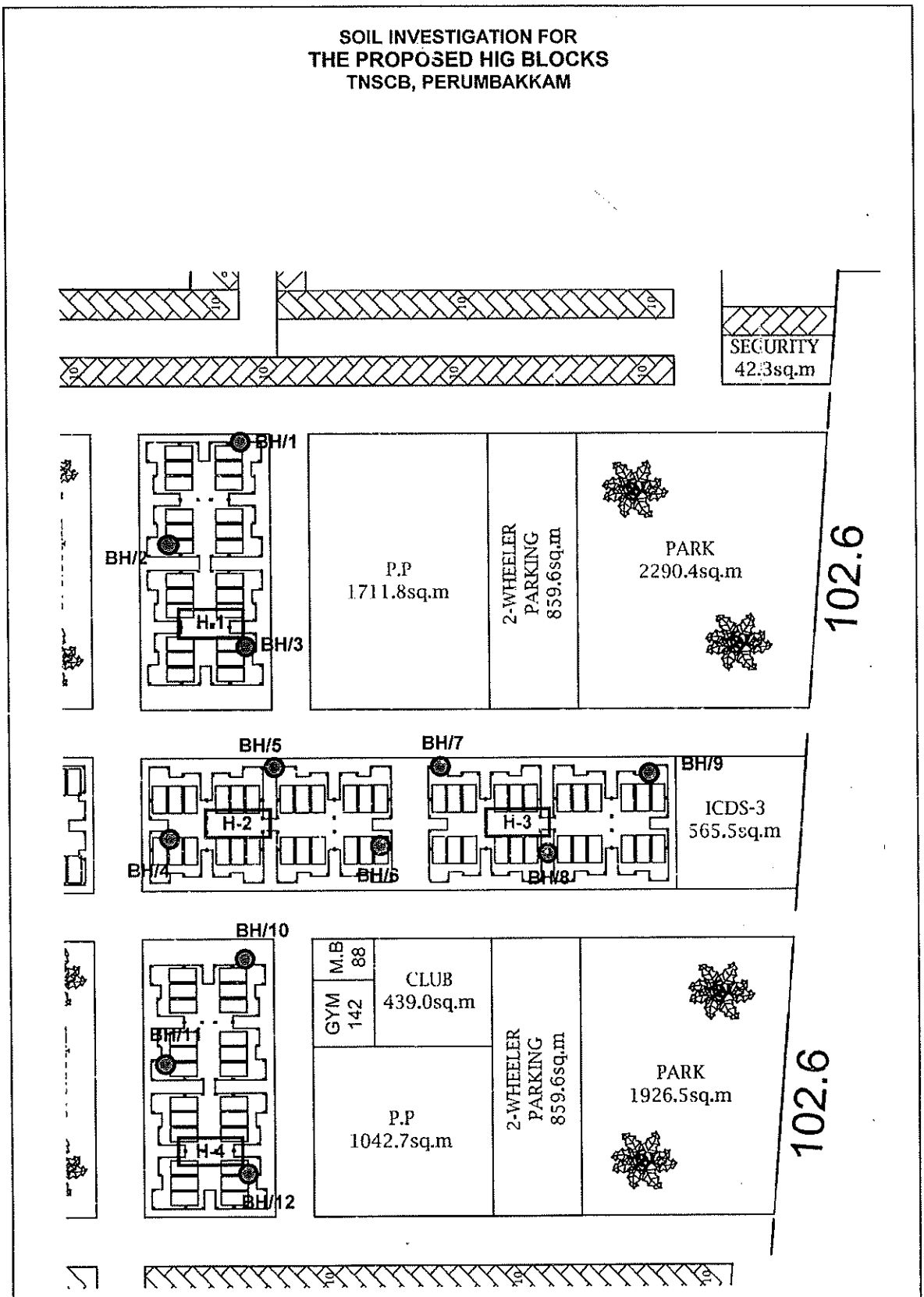
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Figure A1 Perumbakkam Project – Zones of Investigation



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FIGURE 1b LOCATION OF BORE HOLES



Boreholes BH/1, BH/3, BH/4, BH/6, BH/7, BH/9, BH/10 and BH/12 are located 5.0m from the boundary on either side.
Boreholes BH/2, BH/5, BH/8 and BH/11 are located 5.0m from the boundary and mid length along the length of block.

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FIGURE 2 SOIL PROFILE AND SPT N VALUES AT BH 1 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH1

Project : HIG Tenements, TNSCB, Perumbakkam
Site : Perumbakkam
Co-ordinates : Block H-1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 25-Mar-2013
Date of finish : 25-Mar-2013
GWL from GL : 1.30m
Ground level RL : +1.582m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
1.0		Yellowish grey soft to medium stiff silty clay		0.50							
1.4				0.75	0.75	2	1	1	1	2	Soft
1.9		Gr grey med stiff to stiff silty clay with red patches	1.50								Stiff
2.0		Lt brownish grey sandy silty clay with few stones		1.80	1.80	4	7	7	10	14	Stiff
2.4		Yellowish grey sandy silty clay with few stones and white patches		2.55	2.55	10	14	25		39	Hard
3.0		Yell grey & gr grey clayey silty fine to coarse sand with weathered stones		3.50	3.50	25	32	41		73	Very dense
3.3				4.50	4.50	50/15cm				>100	
4.0		Yellowish grey clayey silty fine to coarse sand with weathered stones			5.30	Rebound				RB	
4.4											
5.0											
5.3		Yellowish grey and white highly weathered fractured calcareous sandstone	5.30-6.30		TC core drilling 6.30	Rebound				RB	Very weak
6.0											
7.0			6.30-7.30		Diamond core drilling NX size, recovery nil						Very weak to weak
7.4		Yellowish white highly weathered calcareous sandstone									
8.0			7.30-8.30		Diamond core drilling NX size, recovery 15%, RQD nil						Moderate to weak
8.3		Light brownish grey highly weathered severely jointed rock (gneiss)									
9.0			8.30-9.30		Diamond core drilling NX size, recovery 21%, RQD nil						Moderate to weak
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 5.30m to 6.30m DC core drilling from 6.30m to 9.30m									

Borehole terminated at 9.30m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

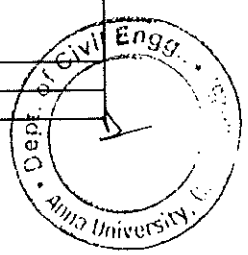


FIGURE 3 SOIL PROFILE AND SPT N VALUES AT BH 2 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH2

Project HIG Tenements, TNSCB, Perumbakkam
Site Perumbakkam
Co-ordinates : Block H-1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 23-Mar-2013
Date of finish : 23-Mar-2013
GWL from GL : 1.20m
Ground level RL : +1.312m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Brownish and yellowish grey silty clay with roots	1.50	0.50							
1.0		Yellowish grey soft silty clay with roots		0.75	0.75	1	1	1	1	2	Soft
1.4		Light brownish grey soft silty clay with reddish brown and yellow patches		1.80	1.80	1	2	5	5	7	
2.2		Yell grey sandy silty clay with weathered stones									Med stiff
2.7				2.55	2.55	15	35	40		75	
3.0		Yellowish grey dirty fine to coarse sand with weathered stones									Very dense
4.0				3.50	3.50	20	32	39		71	
4.6				4.50	4.50	50/10cm				>100	
5.0		Yellowish grey highly weathered fractured rock	4.80-5.50		4.80 Rebound					RB	Very weak
5.5					TC core drilling 5.50 Rebound					RB	
6.0		Brownish grey and highly weathered severely jointed rock (gneiss)	5.50-6.50		Diamond core drilling NX size, recovery nil						Very weak to weak
7.0			6.50-7.50		Diamond core drilling NX size, recovery 20%, RQD nil						Moderate to weak
8.0			7.50-8.50		Diamond core drilling NX size, recovery 25%, RQD nil						
8.1		Light grey brown and weathered jointed rock									Moderate
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 4.80m to 5.50m DC core drilling from 5.50m to 8.50m									

Borehole terminated at 8.50m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

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FIGURE 4 SOIL PROFILE AND SPT N VALUES AT BH 3 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH3

Project HIG Tenements, TNSCB, Perumbakkam
Site Perumbakkam
Co-ordinates : Block H-1
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 6-Mar-2013
Date of finish : 6-Mar-2013
GWL from GL : 1.30m
Ground level RL : +1.550m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	SPT blow counts					
			UDS	DS	m	15	30	45	60	N**	
0.6		Yellowish grey silty clay		0.50							
1.0		Light brownish grey silty clay		0.75	0.75	1	1	2	2	3	Soft
1.6											
2.0		Greenish grey and yellowish grey sandy silty clay with weathered stones		1.80	1.80	5	6	13	15	19	Stiff
2.5											
3.0		Dark yellowish grey dirty fine to coarse sand with weathered stones		2.55	2.55	50/10cm				>100	Very dense
3.5				3.50	3.50	50/6cm				>100	
4.0		Yellowish and brownish dirty fine to coarse sand with weathered stones (weathered disintegrated rock)									
5.0				4.50	4.50	50/10cm				>100	
					5.00	Rebound				RB	
6.0		Brownish grey highly weathered fractured rock	5.00-6.00		TC core drilling 6.00	Rebound				RB	Very weak
7.0		Brownish and grey highly weathered severely jointed rock (gneiss)	6.00-7.00		Diamond core drilling NX size, recovery 13%, RQD nil						Weak
8.0		Light brownish grey highly weathered jointed rock (gneiss)	7.00-8.00		Diamond core drilling NX size, recovery 25%, RQD 10%						Moderate
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 5.00m to 6.00m DC core drilling from 6.00m to 8.00m									

Borehole terminated at 8.00m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

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FIGURE 5 SOIL PROFILE AND SPT N VALUES AT BH 4 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH4

Project : HIG Tenements, TNSCB, Perumbakkam
Site : Perumbakkam
Co-ordinates : Block H-2
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 2-Apr-2013
Date of finish : 2-Apr-2013
GWL from GL : 1.10m
Ground level RL : +1.280m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Yellowish grey silty clay		0.50							Soft
1.0		Light brownish grey soft silty clay with few stones and reddish brown patches		0.75	0.75		1			0	
2.0				1.50	1.50	Sunk @ SPT wt				0	Very soft
2.2											
2.9		Dark grey soft silty clay with fine sand		2.25	2.25	Sunk @ SPT wt				0	
3.0											
3.7		Dark greenish grey dirty fine to coarse sand		3.00	3.00	15	23	32		55	Dense to very dense
4.0		Yell grey dirty fine to coarse sand with stones		3.75	3.75	50/8cm				>100	
4.4					4.40	Rebound				RB	
5.0		Yellowish grey highly weathered fractured rock	4.40-6.10		TC core drilling						Very weak
6.0					6.10	Rebound				RB	
6.1		Light greyish brown highly weathered severely jointed rock (gneiss)	6.10-7.10		Diamond core drilling NX size, reccvery 10%, RQD nil						Weak
7.0											
7.2		Greyish weathered severely jointed rock (vertically jointed rock) (gneiss)	7.10-8.10		Diamond core drilling NX size, recovery 32%, RQD 32%						Moderate to strong
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 4.40m to 6.10m DC core drilling from 6.10m to 8.10m									

Borehole terminated at 8.10m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

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FIGURE 6 SOIL PROFILE AND SPT N VALUES AT BH 5 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH5

Project HIG Tenements, TNSCB, Perumbakkam
Site Perumbakkam
Co-ordinates : Block H-2
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 3-Apr-2013
Date of finish : 3-Apr-2013
GWL from GL : 1.40m
Ground level RL : +1.535m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.8		Yellowish grey silty clay with roots		0.50							Soft
1.0				0.75	0.75		1			0	Very soft
1.8		Light brownish grey silty clay with red patches									
2.0				1.50	1.50	1	1	6	7	7	Stiff
2.4		Light yellowish brown and grey sandy silty clay									
3.0				2.25	2.25	12	22	20	25	42	Dense
3.7		Yell brown clayey silty fine to coarse sand with sandy silty clay patches		3.00	3.00	23	25	30		55	
4.0		Dark yellowish grey dirty fine to coarse sand with weathered stones		3.75	3.75	27	50/10cm			>100	Very dense
4.5					4.50	Rebound				RB	
5.0		Dark yellowish grey highly weathered fractured rock	4.50-6.00		TC core drilling						Very weak
6.0					6.00	Rebound				RB	
6.6		Greyish & brown partly weathered jointed rock	6.00-7.00		Diamond core drilling NX size, recovery 14%, RQD 14%						Weak
7.0		Greyish granitic hard rock with joints (gneiss)	7.00-8.00		Diamond core drilling NX size, recovery 48%, RQD 48%						Moderate to strong
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 4.50m to 6.00m DC core drilling from 6.00m to 8.00m									

Borehole terminated at 8.00m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

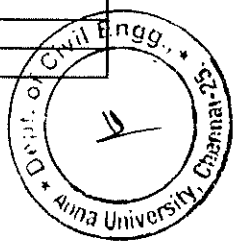


FIGURE 7 SOIL PROFILE AND SPT N VALUES AT BH 6 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH6

Project HIG Tenements, TNSCB, Perumbakkam
Site Perumbakkam
Co-ordinates : Block H-2
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 4-Apr-2013
Date of finish : 5-Apr-2013
GWL from GL : 1.40m
Ground level RL : +1.592m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	SPT blow counts 15	30	45	60	N**	
1.0		Yellowish grey silty clay		0.50							
				0.75	0.75	1	1	2	2	3	Soft
1.4											
2.0		Yellowish grey silty clay with gravel and sand		1.50	1.50	7	16	20	25	36	Very stiff
2.4				2.25	2.25	6	20	25		45	Dense
3.0		Yellowish brown dirty fine to coarse sand with sandy clay lumps									
3.2				3.00	3.00	21	37	42		79	
4.0		Yellowish brown dirty fine to coarse sand with weathered stones		3.75	3.75	50/11cm				>100	Very dense
4.8				4.50	4.50	50/9cm				>100	
5.0					5.10	Rebound				RB	
6.0		Yellowish brown highly weathered fractured rock	5.10-6.20		TC core drilling 6.20	Rebound				RB	Very weak
6.2											
7.0		Dark grey and brown highly weathered severely jointed rock (gneiss)	6.20-7.20		Diamond core drilling NX size, recovery 15%, RQD nil						Weak
7.8											
8.0		Greyish hard rock (gneiss)	7.20-6.20		Diamond core drilling NX size, recovery 32%, RQD 20%						Strong
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 5.10m to 6.20m DC core drilling from 6.20m to 8.20m									

Borehole terminated at 8.20m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

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FIGURE 8 SOIL PROFILE AND SPT N VALUES AT BH 7 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH7

Project HIG Tenements, TNSCB, Perumbakkam
Site Perumbakkam
Co-ordinates : Block H-3
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 9-Apr-2013
Date of finish : 9-Apr-2013
GWL from GL : 1.25m
Ground level RL : +1.456m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	SPT blow counts					
			UDS	DS	m	15	30	45	60	N**	
1.0		Yellowish grey silty clay with brown patches		0.50							
				0.75	0.75	1	1	1	1	2	Soft
1.9											
2.0				1.50	1.50	0	1	3	13	4	
2.5		Greyish and brownish silty clay with stones									Stiff
				2.25	2.25	13	20	18	21	38	
3.0		Greyish brown clayey silty fine to coarse sand									Dense
3.5				3.00	3.00	15	31	36		67	
4.0		Greyish brown dirty fine to coarse sand		3.75	3.75	35	50/6cm			>100	Very dense
4.5				4.50	4.50	50/5cm				>100	
5.0		Dark yellowish grey highly weathered fractured rock			5.10	Rebound				RB	Very weak
			5.10-6.10		TC core drilling						
6.0					6.10	Rebound				RB	
6.1		Brownish and yellowish grey highly weathered severely jointed rock (gneiss)	6.10-7.10		Diamond core drilling NX size, recovery 15%, RQD nil						Weak
7.0											
7.6			7.10-8.10		Diamond core drilling NX size, recovery 37%, RQD 23%						
8.0		Greyish jointed hard rock (gneiss)									Strong
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 5.10m to 6.10m DC core drilling from 6.10m to 8.10m									

Borehole terminated at 8.10m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

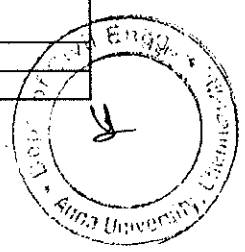


FIGURE 9 SOIL PROFILE AND SPT N VALUES AT BH 8 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH8

Project HIG Tenements, TNSCB, Perumbakkam
Site Perumbakkam
Co-ordinates : Block H-3
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 5-Apr-2013
Date of finish : 6-Apr-2013
GWL from GL : 1.20m
Ground level RL : +1.376m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	SPT blow counts					
			UDS	DS	m	15	30	45	60	N**	
1.0		Yellowish grey silty clay with roots at surface		0.50							
				0.75	0.75	1	1	2	2	3	Soft
1.8				1.50	1.50	3	4	8	10	12	
2.0											
2.9		Light yellowish grey silty clay with few stones		2.25	2.25	4	6	7	10	13	Stiff
3.0											
3.6		Yellowish brown and grey sandy silty clay with weathered stones		3.00	3.00	17	28	32		60	Hard
4.0				3.75	3.75	50/10cm				>100	
		Brownish dirty fine to coarse sand with weathered stones		4.50	4.50	50/6cm				>100	Very dense
5.0					5.00	Rebound				RB	
6.0		Brownish and grey highly weathered fractured rock	5.00-6.00		TC core drilling 6.00	Rebound				RB	Very weak
6.8		Brownish and yellowish grey highly weathered severely jointed rock	6.00-7.00		Diamond core drilling NX size, recovery nil						Weak
7.0		Lt brown & lt grey highly weath jointed rock									Moderate
7.4			7.00-8.00		Diamond core drilling NX size, recovery 58%, RQD 56%						
8.0		Greyish hard rock (gneiss)									Strong
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 5.00m to 6.00m DC core drilling from 6.00m to 8.00m									

Borehole terminated at 8.00m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

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FIGURE 10 SOIL PROFILE AND SPT N VALUES AT BH 9 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH9

Project HIG Tenements, TNSCB, Perumbakkam
Site Perumbakkam
Co-ordinates : Block H-3
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 6-Apr-2013
Date of finish : 8-Apr-2013
GWL from GL : 1.25m
Ground level RL : +1.335m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	SPT blow counts 15	30	45	60	N**	
1.0		Yellowish grey silty clay with roots		0.50							Soft to medium
1.4				0.75	0.75	2	2	2	2	4	
2.0		Yellowish grey silty clay with light grey patches		1.50	1.50	3	4	7	9	11	Stiff
2.1		Greyish brown / yellowish grey sandy silty clay with stones		2.25	2.25	11	20	25	20	45	Stiff
2.9											
3.0		Dark yellowish grey clayey silty sand with weathered stones		3.00	3.00	45	50/5cm			>100	Very dense
3.7				3.75	3.75	50/10cm				>100	
4.0		Dark yell grey dirty fine to coarse sand (comp weathered disintegrated rock)			4.50	Rebound				RB	Very dense
4.5											
5.0		Dark yellowish grey highly weathered fractured rock	4.50-5.80		TC core drilling						Very weak
5.8					5.80	Rebound				RB	
6.0		Light yellowish grey and brown highly weathered severely jointed rock	5.80-6.80		Diamond core drilling NX size, recovery 17%, RQD						Weak to moderate
7.0		Light yellowish grey and brown highly weathered closely jointed rock	6.80-7.80		Diamond core drilling NX size, recovery 26%, RQD nil						Moderate
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 4.50m to 6.80m DC core drilling from 6.80m to 7.80m									
		Borehole terminated at 7.80m									

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

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FIGURE 11 SOIL PROFILE AND SPT N VALUES AT BH 10 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH10

Project HIG Tenements, TNSCB, Perumbakkam
Site Perumbakkam
Co-ordinates : Block H-4
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 14-Mar-2013
Date of finish : 14-Mar-2013
GWL from GL : 1.00m
Ground level RL : +1.210m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	SPT blow counts					
			UDS	DS	m	15	30	45	60	N**	
0.5		Yellowish grey silty clay with coarse particles		0.50							
1.0		Light brownish silty clay		0.75	0.75	0	1	1	1	2	Soft
1.8				1.50	1.50	0	2	12	14	14	
2.0		Greyish sandy silty clay with yellowish brown patches and gravel									Stiff
2.6				2.25	2.25	7	9	18	29	27	
3.0		Brownish grey clayey silty sand with weathered stones & sand clay lumps		3.00	3.00	50/15cm				>100	Very dense
3.6					3.60	Rebound				RB	
4.0		Brownish highly weathered fractured rock	3.60-4.30		TC core drilling 4.30	Rebound				RB	Very weak
4.3		Lt yel grey & brown highly weathered severely weathered jointed rock (gneiss)	4.30-5.30		Diamond core drilling NX size, recovery 14%, RQD nil						Weak to moderate
5.0											
6.0											
7.0											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 3.60m to 4.30m DC core drilling from 4.30m to 5.30m									
		Borehole terminated at 5.30m									

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

FIGURE 12 SOIL PROFILE AND SPT N VALUES AT BH 11 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH11

Project HIG Tenements, TNSCB, Perumbakkam
Site Perumbakkam
Co-ordinates : Block H-4
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 28-Mar-2013
Date of finish : 28-Mar-2013
GWL from GL : 1.30m
Ground level RL : +1.480m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
1.0		Yellowish grey silty clay with roots and reddish brown patches		0.50							Very soft
1.4				0.75	0.75		1		1	0	
2.0		Dark grey very soft silty clay with fine sand		1.50	1.50	Sunk @ SPT wt				0	Very soft
2.7				2.25	2.25	0	1	6	15	7	
3.0		Yellowish grey dirty fine to medium sand									Dense
3.4		Yell grey clayey silty sand with weathered stones		3.00	3.00	7	9	34		43	
3.8					3.75	29/4cm & Rebound				RB	Very dense
4.0		Br and grey highly weathered fractured rock	3.75-4.40		TC core drilling						Very weak
4.5											
5.0		Yellowish grey and grey highly weathered closely jointed rock	4.40-5.40		Diamond core drilling NX size, recovery 13%, RQD nil						Moderate
5.8											
6.0		Greyish jointed hard rock (gneiss)	5.40-6.40		Diamond core drilling NX size, recovery 26%, RQD 14%						Strong
7.0											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 3.75m to 4.40m DC core drilling from 4.40m to 6.40m									

Borehole terminated at 6.40m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

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FIGURE 13 SOIL PROFILE AND SPT N VALUES AT BH 12 - H

PROJECT NO:	SF/KI-49/PMPKM/Zone H
BORE HOLE NO:	BH12

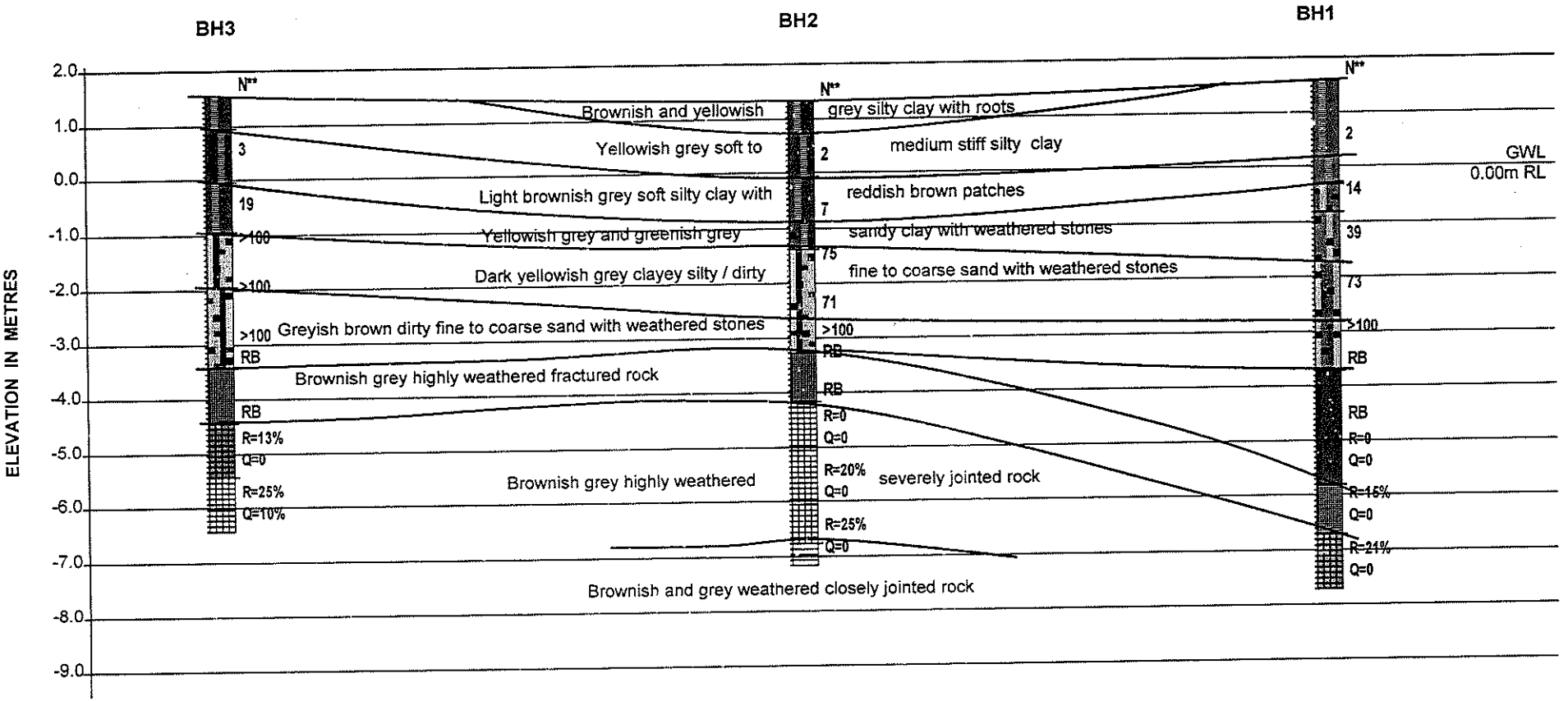
Project : HIG Tenements, TNSCB, Perumbakkam
Site : Perumbakkam
Co-ordinates : Block H-4
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 1-Apr-2013
Date of finish : 1-Apr-2013
GWL from GL : 1.20m
Ground level RL : +1.500m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.7		Yellowish grey silty clay		0.50							
1.0		Brownish grey silty clay with coarse particles		0.75	0.75	1		1		1	Soft to very soft
1.4											
1.9		Greyish very soft silty clay	1.50								
2.0				2.00	2.00	Sunk @ SPT wt				0	
2.6		Greyish very soft silty clay with very fine sand									
3.0		Yellowish grey completely weathered disintegrated rock		2.75	2.75	35	50/10cm			>100	Very dense
3.5					3.50	Rebound				RB	
4.0		Yellowish grey highly weathered fractured rock	3.50-4.50		TC core drilling 4.50	Rebound				RB	Very weak
4.5											
5.0			4.50-5.50		Diamond core drilling NX size, recovery nil						
6.0		Light brownish and grey highly weathered severely jointed rock	5.50-6.50		Diamond core drilling NX size, recovery 15%, RQD nil						Weak
7.0			6.50-7.50		Diamond core drilling NX size, recovery 18%, RQD nil						
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0		Note: Ground level RL is with respect to the site reference datum									
19.0											
20.0		TC core drilling from 3.50m to 4.50m DC core drilling from 4.50m to 7.50m									
		Borehole terminated at 7.50m									

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{65}

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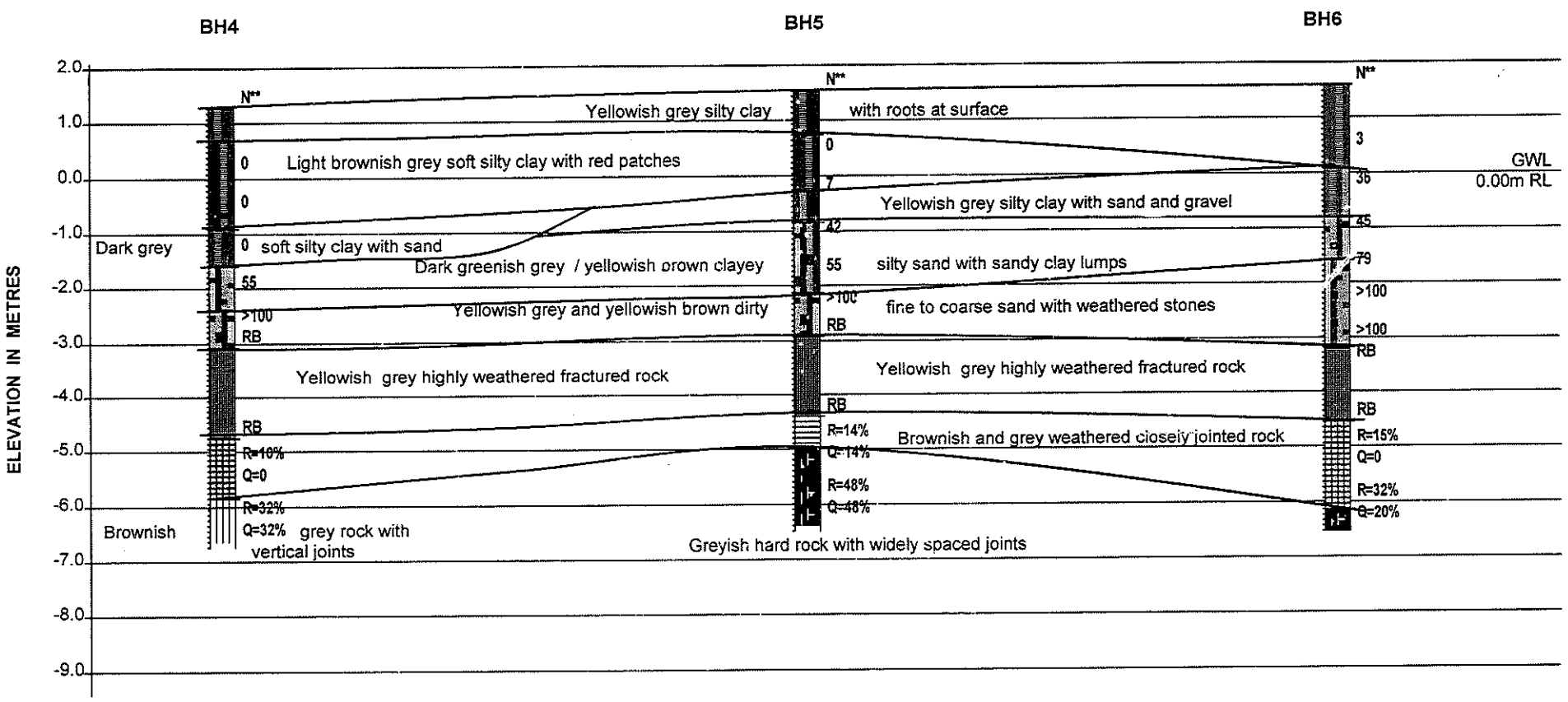


NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes.
The boreholes are not in one alignment and hence the profiles shall be used only to see the variations in the elevation of different layers. Elevations of different layers shall not be interpolated.

FIGURE 14

SUB-SOIL PROFILE BH/3– BH/2 – BH/1 – BLOCK H-1
TNSCB TENEMENTS AT PERUMBAKKAM

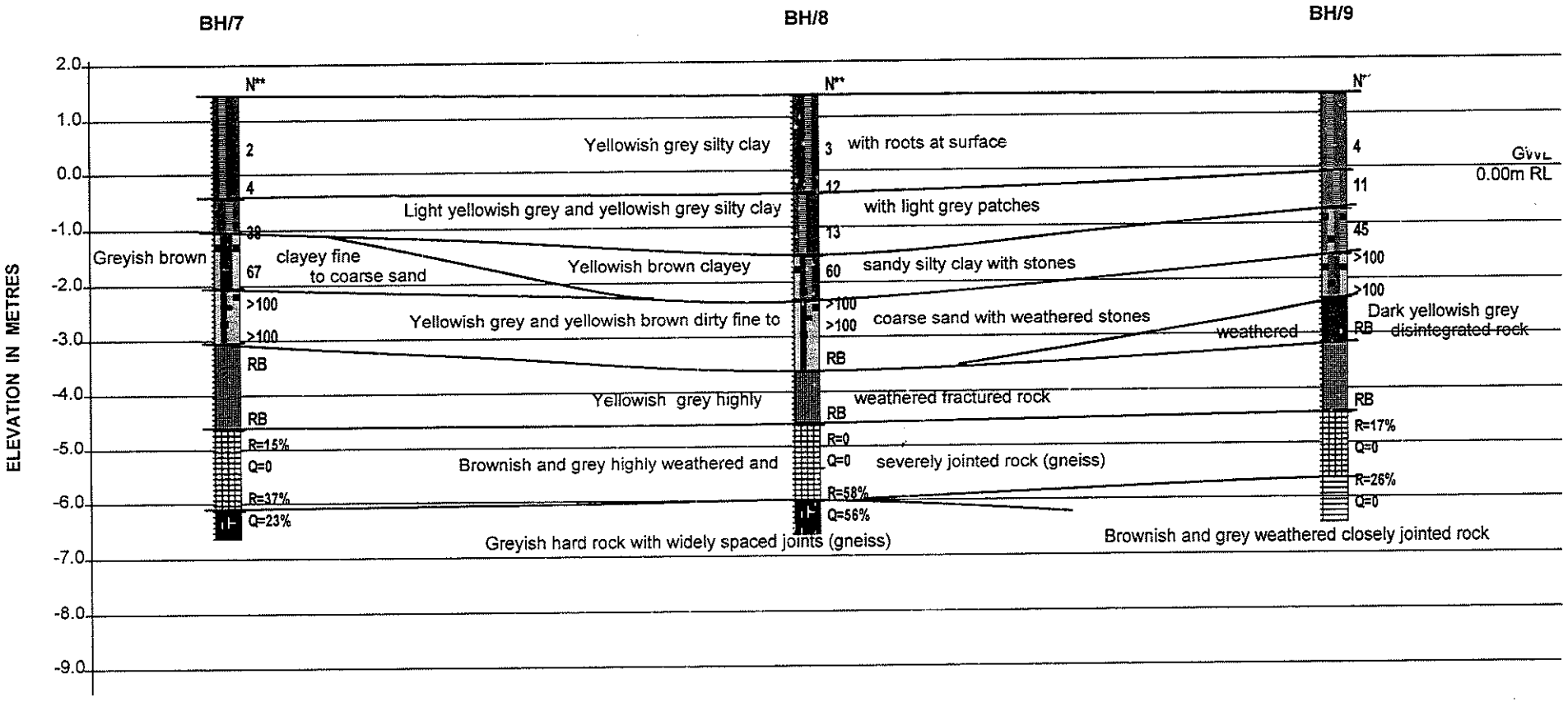
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NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes.
The boreholes are not in one alignment and hence the profiles shall be used only to see the variations in the elevation of different layers. Elevations of different layers shall not be interpolated.

FIGURE 15

SUB-SOIL PROFILE BH/4– BH/5 – BH/6 – BLOCK H-2
TNSCB TENEMENTS AT PERUMBAKKAM

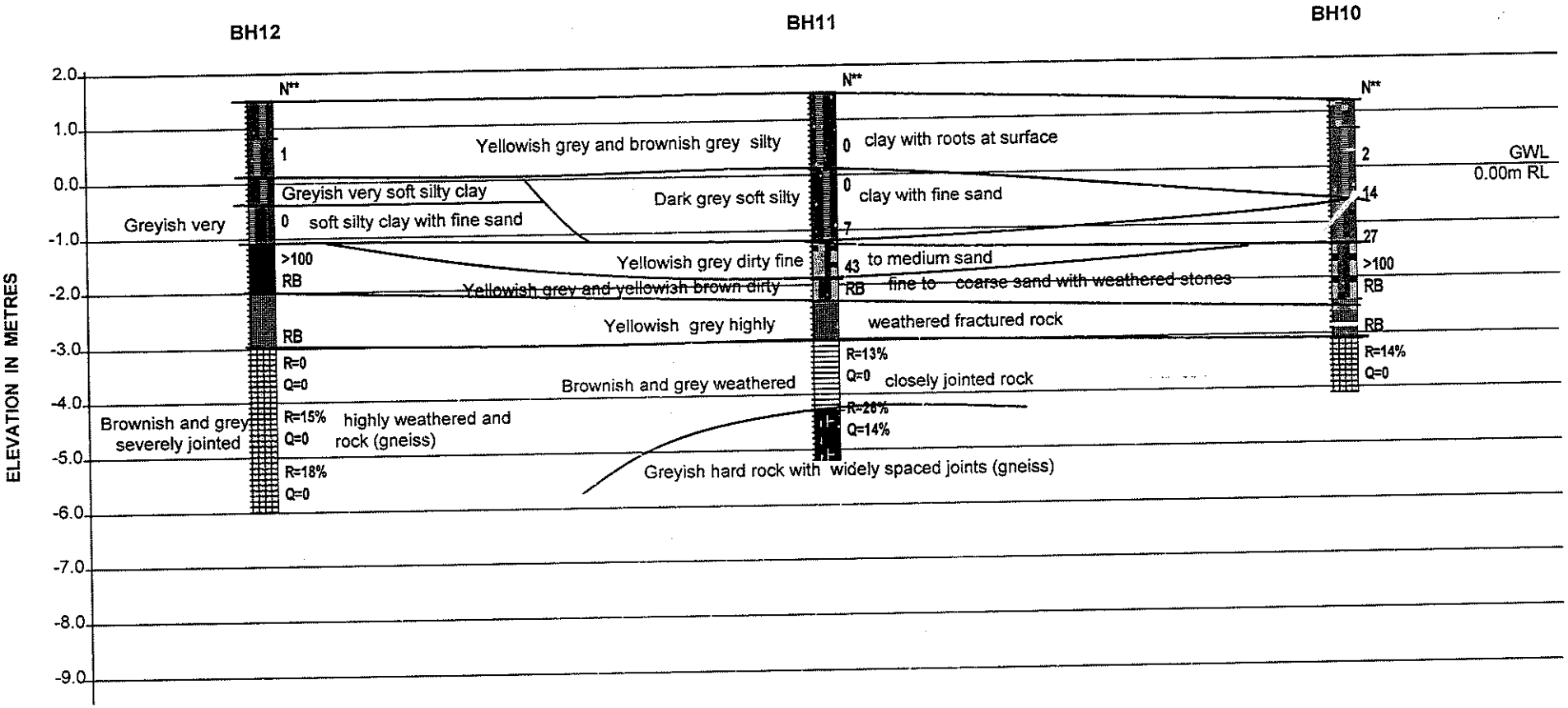


NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes.
The boreholes are not in one alignment and hence the profiles shall be used only to see the variations in the elevation of different layers. Elevations of different layers shall not be interpolated.

FIGURE 16

SUB-SOIL PROFILE BH/7– BH/8 – BH/9 – BLOCK H-3 TNSCB TENEMENTS AT PERUMBAKKAM

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NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes.
The boreholes are not in one alignment and hence the profiles shall be used only to see the variations in the elevation of different layers. Elevations of different layers shall not be interpolated.

FIGURE 17

SUB-SOIL PROFILE BH/12– BH/11 – BH/10 – BLOCK H-4
TNSCB TENEMENTS AT PERUMBAKKAM

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TABLE 1 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 1 - H

Project: **HIG Tenements, Perumabkkam, TNSCB**
Borehole Nos: **BH1**
Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Sample Depth m	Sample Type	Visual Identification of Soil	SPT "N"	Classification	Natural Moisture content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Free Swell Index %	Specific Gravity	Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt %	Clay %
Depth (1)	Type (2)	Description (3)	(4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH1															
GL-0.5	DS	Yellowish grey soft to medium stiff silty clay		CH	26.7	67.6	21.0	46.6	0.122								
0.75	SPT	Yellowish grey soft silty clay with few stones	2	CH	33.9	78.5	22.1	56.4	0.209								
1.50	UDS	Greenish grey medium stiff to stiff silty clay with reddish brown patches		CH	44.7	92.0	25.2	66.8	0.290								
1.80	SPT	Light brownish grey sandy silty clay with few stones	14		20.7												
2.55	SPT	Yellowish grey sandy silty clay with few stones and white patches	39		23.2												
3.50	SPT	Yell grey & gr grey clayey silty fine to coarse sand with weathered stones	73	SC	14.2							11.2	10.1	20.7	25.5	32.5	
4.50	SPT	Yellowish grey clayey silty fine to coarse sand with weathered stones	>100		21.2												
7.30-8.30		Yellowish white highly weathered calcareous sandstone															
8.30-9.30		Light brownish grey highly weathered severely jointed rock															

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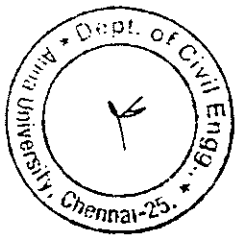


TABLE 2 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 2 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**
Borehole Nos: **BH2**
Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Sample Depth m	Sample Type	Visual Identification of Soil	SPT "N"	Classification	Natural Moisture content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Free Swell Index %	Specific Gravity	Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt %	Clay %
Depth (1)	Type (2)	Description (3)	(4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH2															
0.75	SPT	Yellowish grey soft silty clay with roots	2	CH	35.9	70.0	21.7	48.3	0.294	143.4							
1.50	UDS	TOP: Light brownish grey soft silty clay with reddish brown patches		CH	56.0	86.1	22.2	63.9	0.529	60.0							
		BOT: Light brownish grey soft silty with yellow patches			62.6												
1.80	SPT	TOP: Light brownish grey soft silty clay with yellow patches and gravel	7		37.4												
		BOT: Yellowish grey sandy silty clay with weathered stones		SC/CI	21.3	39.4	16.1	23.3	0.223	33.3							
2.55	SPT	Yellowish grey dirty fine to coarse sand with weathered stones	75	SC/SM	17.1							3.4	10.4	28.8	32.2	25.2	
3.50	SPT	Yellowish grey dirty fine to coarse sand with weathered stones	71	SC/SM	13.9							1.9	10.0	31.4	34.0	22.7	
4.50	SPT	Yellowish grey dirty fine to coarse sand with weathered stones (wdr)	>100		9.8												
6.50-7.50		Brownish grey and highly weathered severely jointed rock															
7.50-8.50		Light grey and brown weathered jointed rock															

498

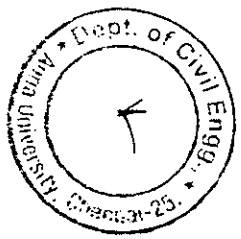


TABLE 3 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 3 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH3**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH3															
GL-0.50	DS	Yellowish grey silty clay		CH	22.5	70.9	21.4	49.5	0.022	70.0							
0.75	SPT	Light brownish grey silty clay	3	CH	41.4	73.0	21.5	51.5	0.386	69.2							
1.80	SPT	Greenish grey and yellowish grey sandy silty clay with weathered stones	19		19.6					40.0							
2.55	SPT	Dark yellowish grey dirty fine to coarse sand with weathered stones	>100	SC/SM	9.0							12.8	20.0	29.6	23.4	14.2	
3.50	SPT	Greyish highly weathered fractured rock	>100		7.1												
4.50	SPT	Yellowish and brownish dirty fine to coarse sand with weathered stones	>100	SW	5.0							22.5	31.5	30.4	13.1	2.5	
6.00-7.00		Brownish grey highly weathered severely jointed rock															
7.00-8.00		Light brownish grey highly weathered jointed rock															

499

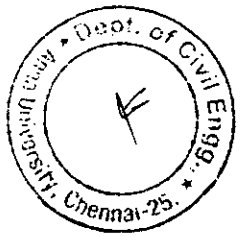


TABLE 4 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 4 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH4**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH4															
GL-0.50	DS	Yellowish grey silty clay		CH	28.0	67.1	21.9	45.2	0.135	75.0							
0.75	SPT	Light brownish grey soft silty clay with few stones	0	CH	58.0	84.4	24.5	59.9	0.559	63.0							
1.50	SPT	Light brownish grey very soft silty clay with reddish brown patches	0	CH	60.0	84.6	22.2	62.4	0.606	83.3							
2.25	SPT	Dark grey soft silty clay with fine sand	0	SC/CI	38.6	48.3	15.7	32.6	0.702	20.0							
3.00	SPT	Dark greenish grey dirty fine to coarse sand	55	SC/SM	17.5							2.9	13.8	30.3	31.1	21.9	
3.75	SPT	Yellowish grey dirty fine to coarse sand with weathered stones	>100	SC/SM	9.7							13.8	21.5	27.2	22.9	14.6	
6.10-7.10		Light greyish brown highly weathered severely jointed rock															
7.10-8.10		Greyish weathered severely jointed rock (vertically jointed rock)															

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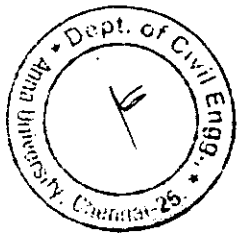


TABLE 5 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 5 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH5**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH5															
GL-0.50	DS	Yellowish grey silty clay with roots		CH	31.7	65.1	20.8	44.3	0.246	45.5							
0.75	SPT	TOP: Yellowish grey silty clay with roots	0	CH	54.2	77.9	23.3	54.6	0.566	69.2							
		BOT: Light brownish grey silty clay with red patches			50.1												
1.50	SPT	TOP: Light brownish grey silty clay with red patches	7	CH	44.8	73.8	22.3	51.5	0.437	71.4							
		BOT: Light yellowish brown and grey sandy silty clay			21.5												
2.25	SPT	Yell brown clayey silty fine to coarse sand with sandy silty clay patches	42	SC/SM	22.3							8.9	14.7	23.8	29.5	23.1	
3.00	SPT	Yell brown & yell grey clayey silty sand with sandy clay lumps & stones	55	SC	17.3							11.8	11.5	18.9	30.5	27.3	
3.75	SPT	Dark yellowish grey dirty fine to coarse sand with weathered stones	>100	SC/SM	10.4							3.3	9.4	32.8	34.9	19.6	
6.00-7.00		Greyish granitic hard rock with joints															
7.00-8.00		Greyish granitic hard rock with joints															

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TABLE 6 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 6 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH6**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH6															
					27.6					80.0							
GL-0.50	DS	Yellowish grey silty clay															
0.75	SPT	Yellowish grey silty clay	3	CH	42.6	77.2	24.2	53.0	0.347	91.6							
1.50	SPT	Yellowish grey silty clay with gravel and sand	36	CH	17.4	64.2	18.6	45.6	<0.00	41.6							
2.25	SPT	TOP: Yellowish brown and light grey silty clay with sand and gravel	45		18.2												
		BOT: Yellowish brown dirty fine to coarse sand with sandy clay lumps		SC/SM	13.8							4.3	13.0	28.5	30.2	24.0	
3.00	SPT	Yellowish brown dirty fine to coarse sand with few weathered stones	79	SC/SM	15.0							2.9	11.9	31.0	30.9	23.3	
3.75	SPT	Yellowish brown dirty fine to coarse sand with weathered stones	>100	SW/SM	8.7							9.4	26.2	32.8	23.8	7.8	
4.50	SPT	Yellowish brown dirty fine to coarse sand with weathered stones	>100		11.0												
6.20-7.20		Dark grey and brown highly weathered severely jointed rock															
7.20-8.20		TOP: Light grey and brown highly weathered severely jointed rock															
7.20-8.20		BOT: Greyish hard rock															

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TABLE 7 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 7 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH7**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH7															
GL-0.50	DS	Yellowish grey silty clay		CH	21.1	63.5	19.4	44.1	0.039	55.0							
0.75	SPT	Yellowish grey and brown silty clay	2	CH	44.1	71.8	20.9	50.9	0.456	81.8							
1.50	SPT	TOP: yellowish grey silty clay with brown patches	4	CH	42.5	75.1	24.4	50.7	0.357	100.0							
		BOT: Greyish and brownish silty clay with stones			21.4												
2.25	SPT	TOP: Light yellowish brown silty clay with sandy clay patches	38		27.2												
		BOT: Greyish brown clayey silty sand / sandy silty clay		SC	16.4							2.9	11.7	27.6	28.0	29.8	
3.00	SPT	Greyish brown clayey silty fine to coarse sand	67		14.9												
3.75	SPT	Greyish brown dirty fine to coarse sand	>100	SC-SM	12.3							6.0	26.2	34.3	17.8	15.7	
4.50	SPT	Dark yellowish grey highly weathered fractured rock	>100		14.0												
6.10-7.10		Brownish and yellowish grey highly weathered severely jointed rock															
7.10-8.10		TOP: Brownish and yellowish grey highly weathered severely jointed rock															
		BOT: Greyish jointed hard rock															

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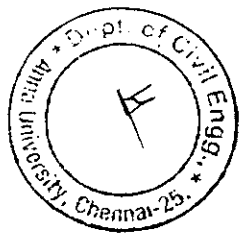


TABLE 8 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 8 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH8**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH8															
GL-0.50	DS	Yellowish grey silty clay with roots		CH	27.9	67.5	21.5	46.0	0.139	70.0							
0.75	SPT	Yellowish grey soft silty clay	3	CH	40.2	67.1	22.3	44.8	0.400	69.5							
1.50	SPT	TOP: Yellowish grey silty clay	12	CH	36.1	71.3	23.9	47.4	0.257	100.0							
		BOT: Light yellowish grey silty clay with few stones			22.9												
2.25	SPT	Yellowish brown silty clay with gravel and stones	13	CH	28.1	60.8	20.0	40.8	0.199	63.6							
3.00	SPT	Yellowish brown and grey sandy silty clay with weathered stones	60		14.8												
3.75	SPT	Brownish dirty fine to coarse sand with weathered stones	>100	SC/SM	11.8							10.4	19.6	30.5	24.2	15.3	
4.50	SPT	Yellowish brown dirty fine to coarse sand with weathered stones	>100		9.0												
7.00-8.00		TOP: Light brownish and light grey highly weathered jointed rock and dark grey spots															
7.00-8.00		BOT: Greyish hard rock															

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TABLE 9 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 9 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH9**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH9															
GL-0.50	DS	Yellowish grey silty clay with roots		CH	25.8	70.0	21.9	48.1	0.081	70.0							
0.75	SPT	Yellowish grey silty clay with roots	4	CH	42.3	74.0	24.0	50.0	0.366	58.8							
1.50	SPT	TOP: Yellowish grey silty clay with light grey patches	11	CH	36.2	73.9	23.8	50.1	0.248	100.0							
		BOT: Yellowish grey silty clay with gravel			13.9												
2.25	SPT	Greyish brown sandy silty clay with stones	45	SC	16.1							1.0	0.2	13.9	59.8	25.1	
3.00	SPT	Dark yellowish grey clayey silty sand with weathered stones	>100	SC/SM	11.4							17.7	15.3	25.8	23.3	17.9	
3.75	SPT	Dark yell grey dirty fine to coarse sand (comp weathered disintegrated rock)	>100	SP	8.2							2.2	18.9	48.6	25.7	4.6	
5.80-6.80		Light yellowish grey and brown highly weathered severely jointed rock															
6.80-7.80		Light yellowish grey and brown highly weathered closely jointed rock															

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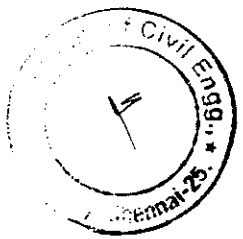


TABLE 10 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 10 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH10**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH10															
GL-0.50	DS	Yellowish grey silty clay with coarse particles		CH	28.1	55.7	17.8	37.9	0.272	70.0							
0.75	SPT	Light brownish silty clay	2	CH	47.5	82.3	23.2	59.1	0.411	75.0							
1.50	SPT	TOP: Brownish grey soft silty clay with stones and yellow patches	14		41.2												
		BOT: Greyish sandy silty clay with yellowish brown patches and gravel	27		43.0												
2.25	SPT	Brownish grey clayey silty sand with weathered stones & sand clay lumps		SC	19.8							6.9	13.1	20.3	29.3	30.4	
3.00	SPT	Dark brownish grey clayey silty fine to coarse sand with weathered stones	>100														
4.30-5.30		Lt yel grey & brown highly weathered severely weathered jointed rock															

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TABLE 11 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 11 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH11**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH11															
GL-0.50	DS	Yellowish grey silty clay with roots			25.6					63.0							
0.75	SPT	Light brownish grey silty clay with reddish brown patches	0	CH	39.8	66.2	18.2	48.0	0.450	68.8							
1.50	SPT	Dark grey very soft silty clay with fine sand	0	CI	35.1	40.8	12.8	28.0	0.796	40.0							
2.25	SPT	TOP: Dark grey soft sandy clay with decayed wood	7	CI	41.3	46.4	15.7	30.7	0.834	40.0							
		BOT: Yellowish grey dirty fine to medium sand		SC/SM	17.0							2.7	6.6	24.3	41.3	25.1	
3.00	SPT	Greyish brown clayey silty sand with sandy clay lumps	43	SC/SM	17.7							6.1	8.5	24.5	38.5	22.4	
3.75	SPT	Yellowish grey clayey silty sand with weathered stones	>100		15.4												
4.40-5.40		Yellowish grey and grey highly weathered closely jointed rock															
5.40-6.40		Greyish jointed hard rock															

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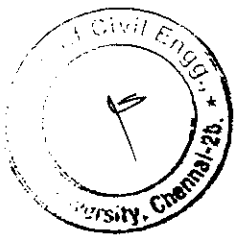


TABLE 12 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 12 - H

Project: **HIG Tenements, Perumbakkam, TNSCB**

Borehole Nos: **BH12**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.20m to 1.50m, March-April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH12															
					11.3					60.0							
GL-0.50	DS	Yellowish grey silty clay															
0.75	SPT	Brownish grey silty clay with coarse particles	1	CH	50.7	71.7	21.0	50.7	0.586	90.0							
1.50	UDS	TOP: Greyish very soft silty clay		CH	44.8	55.1	16.7	38.4	0.732	50.0							
		BOT: Greyish very soft silty clay with very fine sand		CI	40.2	46.7	15.8	30.9	0.790								
2.00	SPT	Greyish very soft silty clay with very fine sand	0	CH	37.2	51.2	21.0	30.2	0.536	50.0							
2.75	SPT	Yellowish grey completely weathered disintegrated rock	>100	SC/SM	11.7							21.2	13.6	18.8	29.6	16.8	
5.50-6.50		Light brownish and grey highly weathered severely jointed rock															
6.50-7.50		Light brownish and grey highly weathered severely jointed rock															

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TABLE 13 SHEAR STRENGTH PARAMETERS FOR DIFFERENT LAYERS

TNSCB, HIG, PERUMBAKKAM, Ground water table = 1.00m to 1.20m (March-April 2013)

Borehole BH/1 (GL = 1.582m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.40m	Yellowish grey soft to medium stiff silty clay, LI=0.12 to 0.21	2	4		c_u = 2.5 t/m²	46-56%	
1.40m to 1.90m	Gr grey med stiff to stiff silty clay with red patches, LI=0.29, Lab c_u=2.9t/m²		6		c_u = 3.0 t/m²	66.8%	P_c=24 t/m², CR=0.258, RR=0.0187
1.90m to 2.40m	Lt brownish grey sandy silty clay with few stones	14	14		c_u = 7.0 t/m²		m_v= 1/(48N) m²/t
2.40m to 3.30m	Yellowish grey sandy silty clay with few stones and white patches	39	40		c_u = 20 t/m²		m_v= 1/(48N) m²/t
3.30m to 4.40m	Yell grey & gr grey clayey silty fine to coarse sand with weathered stones	73	50	ϕ = 40°			C using q_c= 28 N t/m²
4.40m to 5.30m	Yellowish grey clayey silty fine to coarse sand with weathered stones	100	100	ϕ = 42°			C using q_c= 28 N t/m²
5.30m to 7.40m	Yellowish grey and white highly weathered fractured calcareous sandstone	RB	>200		c_u = 100 t/m²		C using q_c= 35 N t/m²
7.40m to 8.30m	Yellowish white highly weathered calcareous sandstone						
8.30m to 9.30m	Light brownish grey highly weathered severely jointed rock (gneiss)						

Borehole BH/2 (GL = 1.312m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Brownish and yellowish grey silty clay with roots						
0.60m to 1.40m	Yellowish grey soft silty clay with roots, LI=0.294	2	2		c_u = 1.25 t/m²	48%	
1.40m to 2.20m	Light brownish grey soft silty clay with reddish brown and yellow patches, LI=0.53-0.60, Lab c_u=0.92t/m²	2,4	3		c_u = 1.5 t/m²	64%	P_c=8.5 t/m², CR=0.2805, RR=0.0414
2.20m to 2.70m	Yell grey sandy silty clay with weathered stones, LI=0.223	7,10	8		c_u = 5.0 t/m²	33%	m_v= 1/(48N) m²/t
2.70m to 4.60m	Yellowish grey dirty fine to coarse sand with weathered stones	75,71,>100	50	ϕ = 40°			C using q_c= 28 N t/m²
4.60m to 5.50m	Yellowish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
5.50m to 8.10m	Brownish grey and highly weathered severely jointed rock (gneiss)						
8.10m to 8.50m	Light grey brown and weathered jointed rock						

Borehole BH/3 (GL = 1.550m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Yellowish grey silty clay					49%	
0.60m to 1.60m	Light brownish grey silty clay, LI=0.386	3	3		c_u = 2.0 t/m²	51.5%	
1.60m to 2.50m	Greenish grey and yellowish grey sandy silty clay with weathered stones	19	18		c_u = 9.0 t/m²		m_v= 1/(48N) m²/t
2.50m to 3.50m	Dark yellowish grey dirty fine to coarse sand with weathered stones	>100	50	ϕ = 40°			C using q_c= 28 N t/m²
3.50m to 5.00m	Yellowish and brownish dirty fine to coarse sand with weathered stones (weathered disintegrated rock)	>100	100	ϕ = 42°			C using q_c= 30 N t/m²
5.00m to 6.00m	Brownish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
6.00m to 7.00m	Brownish and grey highly weathered severely jointed rock (gneiss)						
7.00m to 8.00m	Light brownish grey highly weathered jointed rock (gneiss)						

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Borehole BH/4 (GL =1.280m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Yellowish grey silty clay, LI=0.135					45%	
0.60m to 2.20m	Light brownish grey soft silty clay with few stones and reddish brown patches, LI=0.60	0	2		c_u = 1.0 t/m²	60%	
2.20m to 2.90m	Dark grey soft silty clay with fine sand, LI=0.702	0	2		c_u = 1.0 t/m²	32.5%	
2.90m to 3.70m	Dark greenish grey dirty fine to coarse sand	55	50	ϕ = 38°			C using q_c= 26 N t/m²
3.70m to 4.40m	Yell grey dirty fine to coarse sand with stones	>100	100	ϕ = 40°			C using q_c= 30 N t/m²
4.40m to 6.10m	Yellowish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 40 N t/m²
6.10m to 7.20m	Light greyish brown highly weathered severely jointed rock (gneiss)						
7.20m to 8.10m	Greyish weathered severely jointed rock (vertically jointed rock) (gneiss)						

Borehole BH/5 (GL = 1.535m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.80m	Yellowish grey silty clay with roots, LI=0.246					44%	
0.80m to 1.80m	Light brownish grey silty clay with red patches, LI=0.437 - 0.566	0,2	2		c_u = 1.0 t/m²	52-55%	
1.80m to 2.40m	Light yellowish brown and grey sandy silty clay	6	6		c_u = 3.0 t/m²		
2.40m to 3.70m	Yell brown clayey silty fine to coarse sand with sandy silty clay patches	42,55	45	ϕ = 37°			C using q_c= 26 N t/m²
3.70m to 4.50m	Dark yellowish grey dirty fine to coarse sand with weathered stones	>100	70	ϕ = 42°			C using q_c= 28 N t/m²
4.50m to 6.00m	Dark yellowish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 40 N t/m²
6.00m to 6.60m	Greyish & brown partly weathered jointed rock						
6.60m to 8.00m	Greyish granitic hard rock with joints (gneiss)						

Borehole BH/6 (GL = 1.592m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.40m	Yellowish grey silty clay, LI=0.347	3	3		c_u = 2.0 t/m²	53%	
1.40m to 2.40m	Yellowish grey silty clay with gravel and sand, LI=0	36	36		c_u = 18 t/m²	45.6%	m_v= 1/(42N) m²/t
2.40m to 3.20m	Yellowish brown dirty fine to coarse sand with sandy clay lumps	45	45	ϕ = 37°			C using q_c= 26 N t/m²
3.20m to 4.80m	Yellowish brown dirty fine to coarse sand with weathered stones	79,>100	70	ϕ = 42°			C using q_c= 28 N t/m²
4.80m to 6.20m	Yellowish brown highly weathered fractured rock	RB	>200		c_u = 100 t/m²		C using q_c= 40 N t/m²
6.20m to 7.80m	Dark grey and brown highly weathered severely jointed rock (gneiss)						
7.80m to 8.20m	Greyish hard rock (gneiss)						

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Borehole BH/7 (GL = 1.456m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.90m	Yellowish grey silty clay with brown patches, LI=0.357-0.456	2,4	4		c_u = 2.0 t/m²	44-51%	
1.90m to 2.50m	Greyish and brownish silty clay with stones	13	12		c_u = 6.0 t/m²	41%	m_v= 1/(42N) m²/t
2.50m to 3.50m	Greyish brown clayey silty fine to coarse sand	38	38	ϕ = 36°			C using q_c= 24 N t/m²
3.50m to 4.50m	Greyish brown dirty fine to coarse sand	>100	70	ϕ = 42°			C using q_c= 28 N t/m²
4.50m to 6.10m	Dark yellowish grey highly weathered fractured rock	RB	>200		c_u = 100 t/m²		C using q_c= 40 N t/m²
6.10m to 7.60m	Brownish and yellowish grey highly weathered severely jointed rock (gneiss)						
7.60m to 8.10m	Greyish jointed hard rock (gneiss)						

Borehole BH/8 (GL = 1.376m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.80m	Yellowish grey silty clay with roots at surface, 0.257-0.400	3,7	4		c_u = 2.5 t/m²	45-47.5%	
1.80m to 2.90m	Light yellowish grey silty clay with few stones, LI=0.199	12,13	12		c_u = 6.0 t/m²	41%	m_v= 1/(42N) m²/t
2.90m to 3.60m	Yellowish brown and grey sandy silty clay with weathered stones	60	50		c_u = 25 t/m²		m_v= 1/(48N) m²/t
3.60m to 5.00m	Brownish dirty fine to coarse sand with weathered stones	>100	100	ϕ = 42°			C using q_c= 30 N t/m²
5.00m to 6.00m	Brownish and grey highly weathered fractured rock	RB	>200		c_u = 100 t/m²		C using q_c= 40 N t/m²
6.00m to 6.80m	Brownish and yellowish grey highly weathered severely jointed rock						
6.80m to 7.40m	Lt brown & lt grey highly weathered jointed rock						
7.40m to 8.00m	Greyish hard rock (gneiss)						

Borehole BH/9 (GL = 1.335m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.40m	Yellowish grey silty clay with roots, LI=0.366	4	4		c_u = 2.5 t/m²	48-50%	
1.40m to 2.10m	Yellowish grey silty clay with light grey patches, LI=0.248	11	10		c_u = 5.0 t/m²	50%	m_v= 1/(42N) m²/t
2.10m to 2.90m	Greyish brown / yellowish grey sandy silty clay with stones	45	40	Φ=36°			C using q_c= 24 N t/m²
2.90m to 3.70m	Dark yellowish grey clayey silty sand with weathered stones	>100	70	ϕ = 42°			C using q_c= 26 N t/m²
3.70m to 4.50m	Dark yell grey dirty fine to coarse sand (comp weathered disintegrated rock)	>100	70	ϕ = 42°			C using q_c= 30 N t/m²
4.50m to 5.80m	Dark yellowish grey highly weathered fractured rock	RB	>200		c_u = 100 t/m²		C using q_c= 40 N t/m²
5.80m to 7.00m	Light yellowish grey and brown highly weathered severely jointed rock						
7.00m to 7.80m	Light yellowish grey and brown highly weathered closely jointed rock						

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Borehole BH/10 (GL = 1.210m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.50m	Yellowish grey silty clay with coarse particles, LI=0.272					38%	
0.50m to 1.80m	Light brownish silty clay, LI=0.411	2	2		c_u = 1.2 t/m²	59%	
1.80m to 2.60m	Greyish sandy silty clay with yellowish brown patches and gravel	14	14		c_u = 7.0 t/m²		m_v= 1/(42N) m²/t
2.60m to 3.60m	Brownish grey clayey silty sand with weathered stones & sand clay lumps	40,>100	45	ϕ = 37°			C using q_c= 26 N t/m²
3.60m to 4.30m	Brownish highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 40 N t/m²
4.30m to 5.30m	Lt yel grey & brown highly weathered severely weathered jointed rock (gneiss)						

Borehole BH/11 (GL = 1.480m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.40m	Yellowish grey silty clay with roots and reddish brown patches, LI=0.45	0	2		c_u = 1.2 t/m²	48%	
1.40m to 2.70m	Dark grey very soft silty clay with fine sand, LI=0.796-0.834	0,1	2		c_u = 1.2 t/m²	30%	
2.70m to 3.40m	Yellowish grey dirty fine to medium sand	15	18	ϕ = 32°			C using q_c= 26 N t/m²
3.40m to 3.80m	Yell grey clayey silty sand with weathered stones	>50	50	ϕ = 40°			C using q_c= 26 N t/m²
3.80m to 4.50m	Br and grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 40 N t/m²
4.50m to 5.80m	Yellowish grey and grey highly weathered closely jointed rock						
5.80m to 6.40m	Greyish jointed hard rock (gneiss)						

Borehole BH/12 (GL = 1.500m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.70m	Yellowish grey silty clay						
0.70m to 1.40m	Brownish grey silty clay with coarse particles, LI=0.586	1	2		c_u = 1.2 t/m²	50.7%	
1.40m to 1.90m	Greyish very soft silty clay, LI=0.732	0	2		c_u = 1.2 t/m²	38.5%	
1.90m to 2.60m	Greyish very soft silty clay with very fine sand, LI=0.536 -0.790	0	2		c_u = 1.2 t/m²	30-31%	
2.60m to 3.50m	Yellowish grey completely weathered disintegrated rock	>100	70	ϕ = 42°			C using q_c= 28 N t/m²
3.50m to 4.50m	Yellowish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 40 N t/m²
4.50m to 7.50m	Light brownish and grey highly weathered severely jointed rock						

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TABLE 14 CHEMICAL ANALYSIS ON GROUND WATER SAMPLES (COLLECTED FROM BOREHOLES)

Sample No:	Block	Location	Depth	pH	Sulphate (as SO_4) ppm	Chloride Cl ppm	Remarks
1	H1	BH/1	1.30m	7.35	1065	17730	
2	H2	BH/5	1.40m	7.65	785	13350	
3	H3	BH/8	1.20m	8.20	750	12650	
4	H4	BH/12	1.20m	8.25	890	14100	

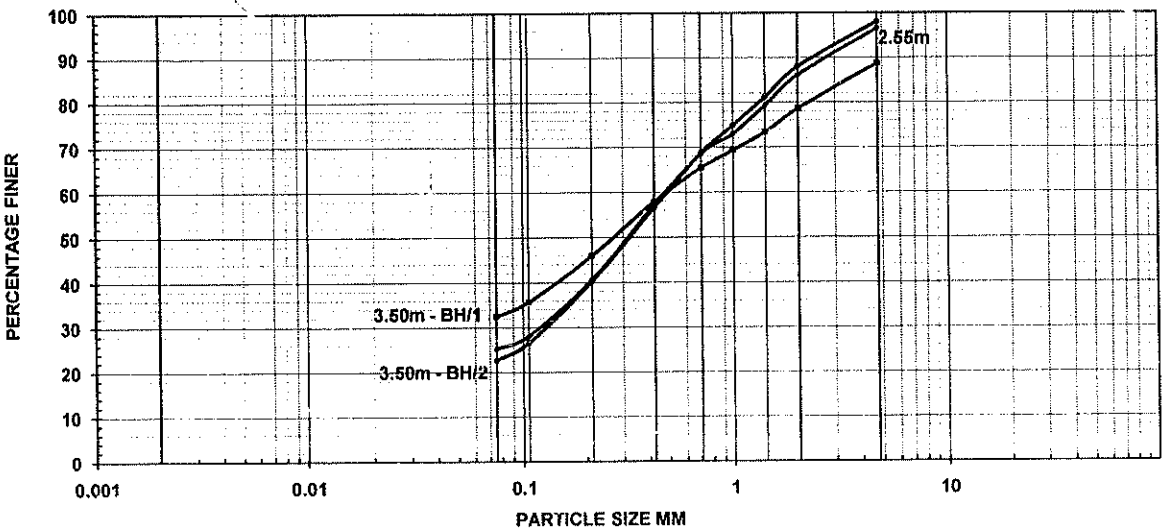
CHEMICAL ANALYSIS ON SOIL SAMPLES

Sample No:	Block	Location	Depth	pH	Sulphate (as SO_4)%	Chloride Cl%	Remarks
1	H1	BH/1	1.50m	8.10	0.020	0.060	
2	H2	BH/6	0.75m	8.15	0.040	0.230	
3	H3	BH/8	0.75m	8.07	0.030	0.210	
4	H4	BH/12	0.75m	6.50	0.050	0.340	

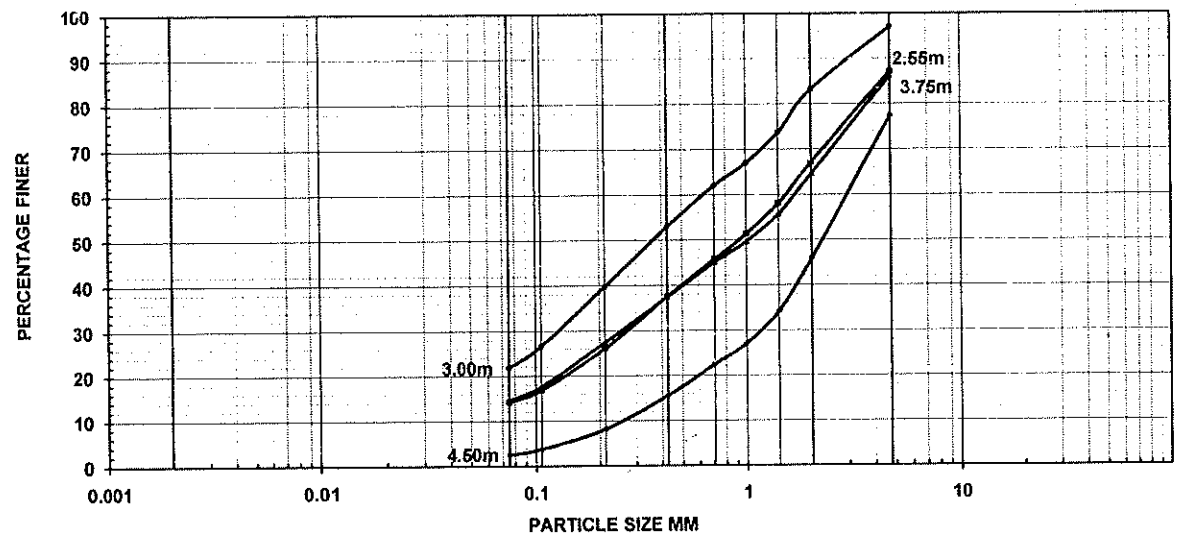
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ANNEXURE G-1

GRAIN SIZE DISTRIBUTION CURVES PROJECT: **HIG Tenements, TNSCB, Perumbakkam**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/1	3.50m		100.0	86.8	78.7	58.0	32.5		11.2	10.1	20.7	25.5	32.5		GC-SP	0.267	10.057	0.539
BH/2	2.55m		100.0	96.6	86.2	57.4	25.2		3.4	10.4	28.8	32.2	25.2		SC-SP	0.312	5.795	0.743
BH/2	3.50m		100.0	96.1	88.1	56.7	22.7		1.9	10.0	31.4	34.0	22.7		SC-SP	0.320	5.605	0.778



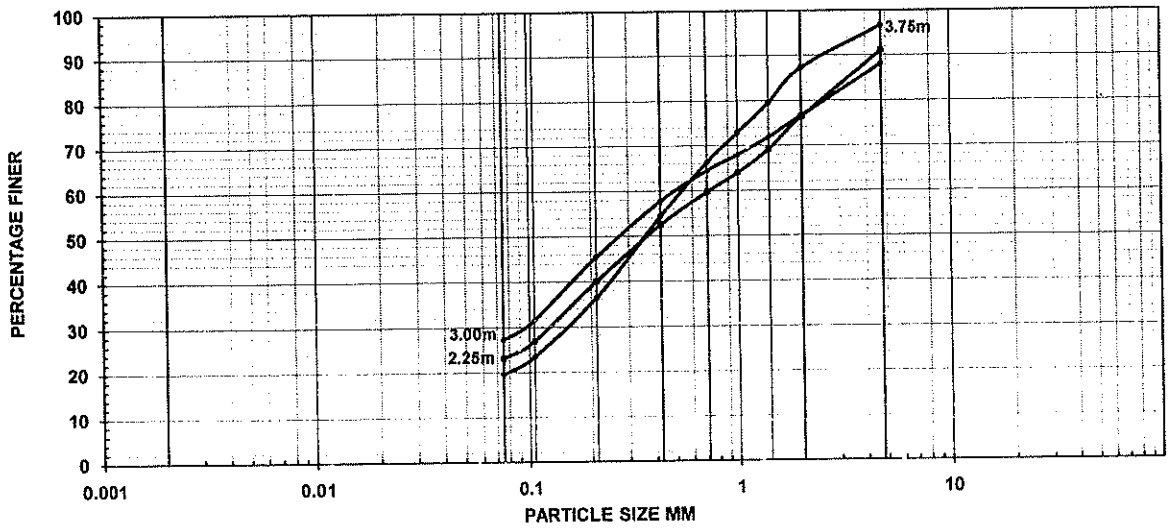
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/3	2.55m		100.0	87.2	67.2	37.6	14.2		12.8	20.0	29.6	23.4	14.2		GC-SP	0.918	11.413	0.778
BH/3	4.50m		100.0	77.5	46.0	15.6	2.5		22.5	31.5	30.4	13.1	2.5		GSW	2.232	8.199	1.951
BH/4	3.00m		100.0	97.1	83.3	53.0	21.9		2.9	13.8	30.3	31.1	21.9		SC-SP	0.363	8.744	0.895
BH/4	3.75m		100.0	86.2	64.7	37.5	14.6		13.8	21.5	27.2	22.9	14.6		GC-SP	1.017	13.209	0.814

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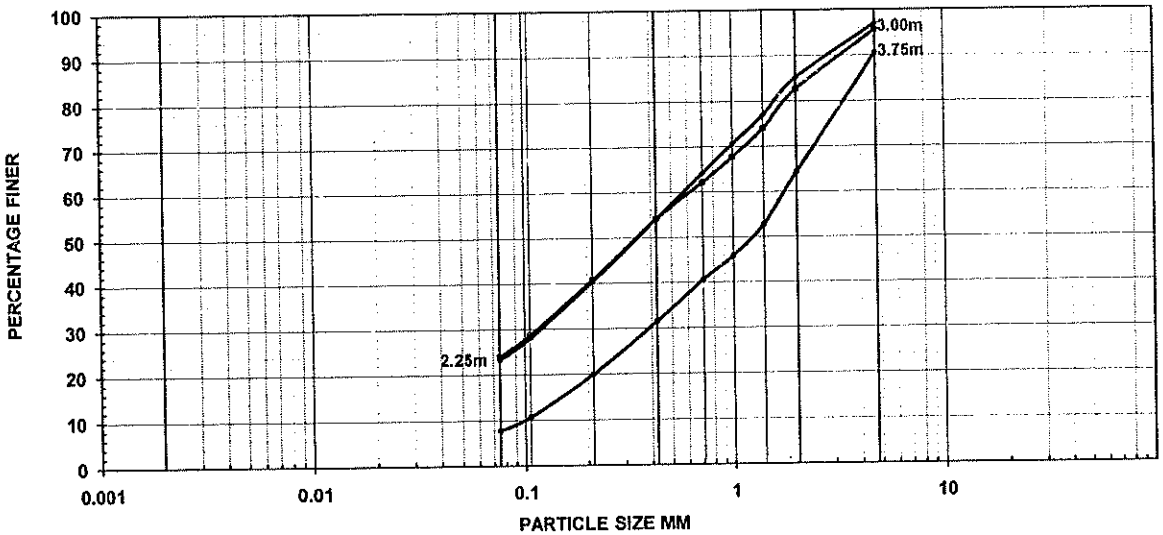
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ANNEXURE G-2

GRAIN SIZE DISTRIBUTION CURVES PROJECT: **HIG Tenements, TNSCB, Perumbakkam**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/5	2.25m		100.0	91.1	76.4	52.6	23.1		8.9	14.7	23.8	29.5	23.1		SC-SP	0.368	10.791	0.484
BH/5	3.00m		100.0	88.2	76.7	57.8	27.3		11.8	11.5	18.9	30.5	27.3		GC-SP	0.273	10.468	0.428
BH/5	3.75m		100.0	96.7	87.3	54.5	19.6		3.3	9.4	32.8	34.9	19.6		SC-SP	0.357	5.794	0.775



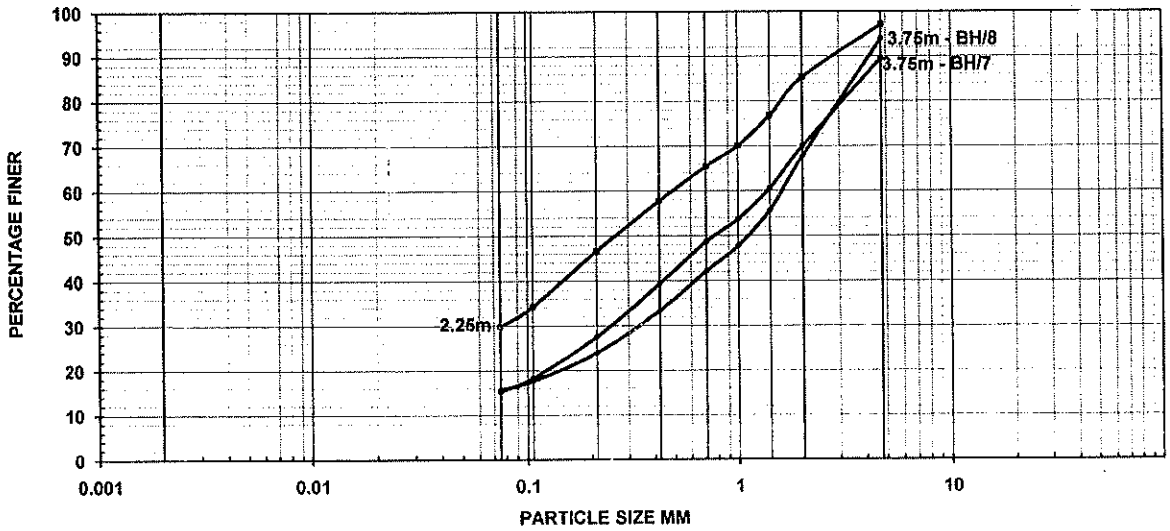
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/6	2.25m		100.0	95.7	82.7	54.2	24.0		4.3	13.0	28.5	30.2	24.0		SC-SP	0.342	8.786	0.611
BH/6	3.00m		100.0	97.1	85.2	54.2	23.3		2.9	11.9	31.0	30.9	23.3		SC-SP	0.344	7.421	0.704
BH/6	3.75m		100.0	90.6	64.4	31.6	7.8		9.4	26.2	32.8	23.8	7.8		GSP	1.218	11.347	0.861

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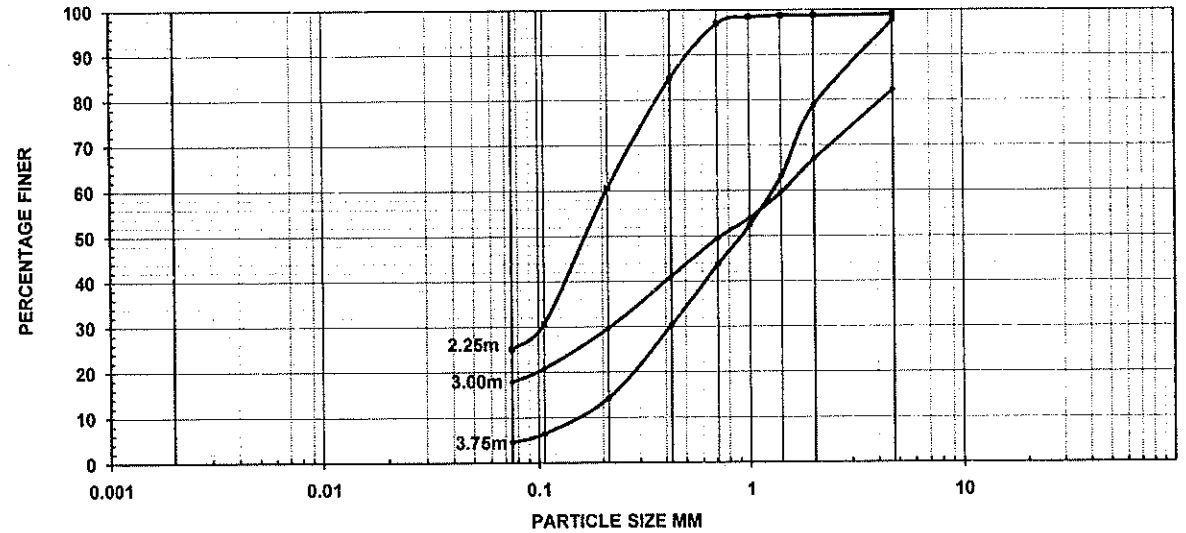
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ANNEXURE G-3

GRAIN SIZE DISTRIBUTION CURVES **PROJECT:** **HIG Tenements, TNSCB, Perumbakkam**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	SI	C	CLASS			
BH/7	2.25m		100.0	97.1	85.4	57.8	29.8		2.9	11.7	27.6	28.0	29.8		SC-SP	0.261	8.981	0.566
BH/7	3.75m		100.0	94.0	67.8	33.5	15.7		6.0	26.2	34.3	17.8	15.7		SC-SW	1.095	8.936	1.057
BH/8	3.75m		100.0	89.6	70.0	39.5	15.3		10.4	19.6	30.5	24.2	15.3		GC-SP	0.771	10.829	0.750



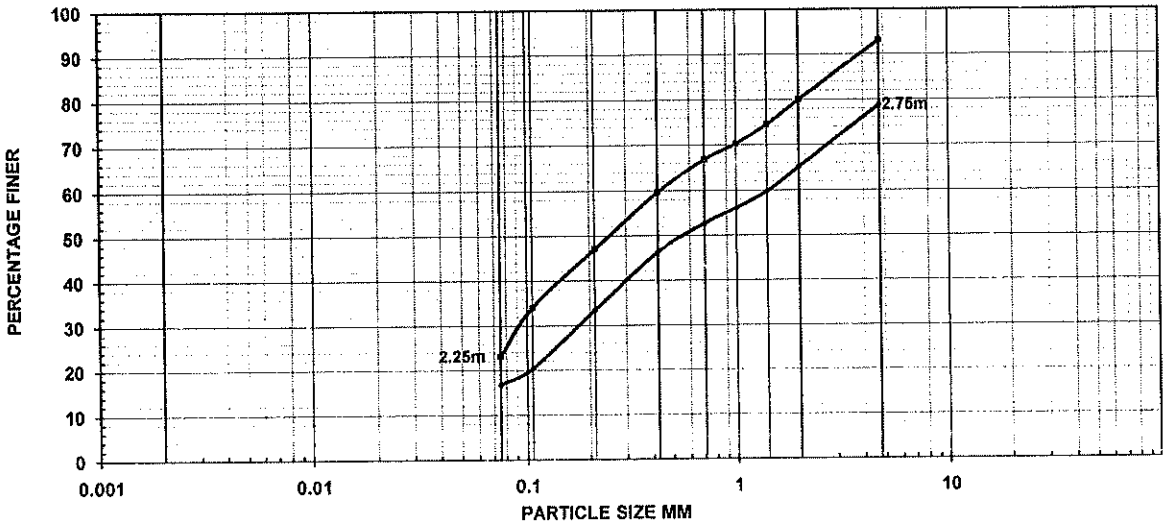
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	SI	C	CLASS			
BH/9	2.25m		100.0	99.0	98.8	84.9	25.1		1.0	0.2	13.9	59.8	25.1			0.166	2.498	0.798
BH/9	3.00m		100.0	82.3	67.0	41.2	17.9		17.7	15.3	25.8	23.3	17.9			0.733	12.568	0.662
BH/9	3.75m		100.0	97.8	78.9	30.3	4.6		2.2	18.9	48.6	25.7	4.6			0.906	6.418	0.804

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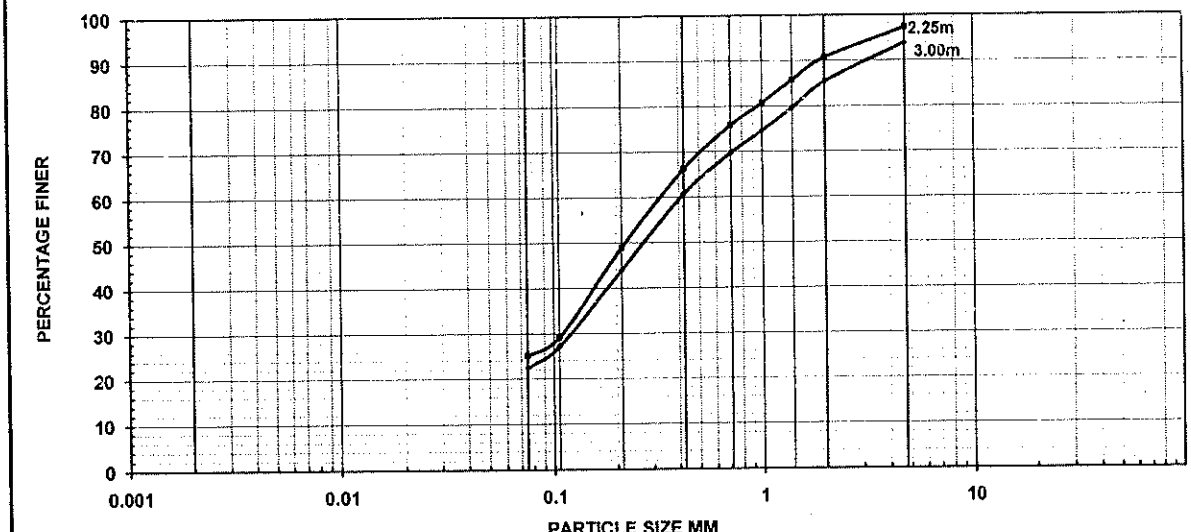
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ANNEXURE G-4

GRAIN SIZE DISTRIBUTION CURVES PROJECT: **HIG Tenements, TNSCB, Perumbakkam**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/10	2.25m		100.0	93.1	80.0	59.7	23.1		6.9	13.1	20.3	36.6	23.1		SC-SP	0.249	9.391	0.473
BH/12	2.75m		100.0	78.8	65.2	46.4	16.8		21.2	13.6	18.8	29.6	16.8		GC-SP	0.567	15.261	0.387

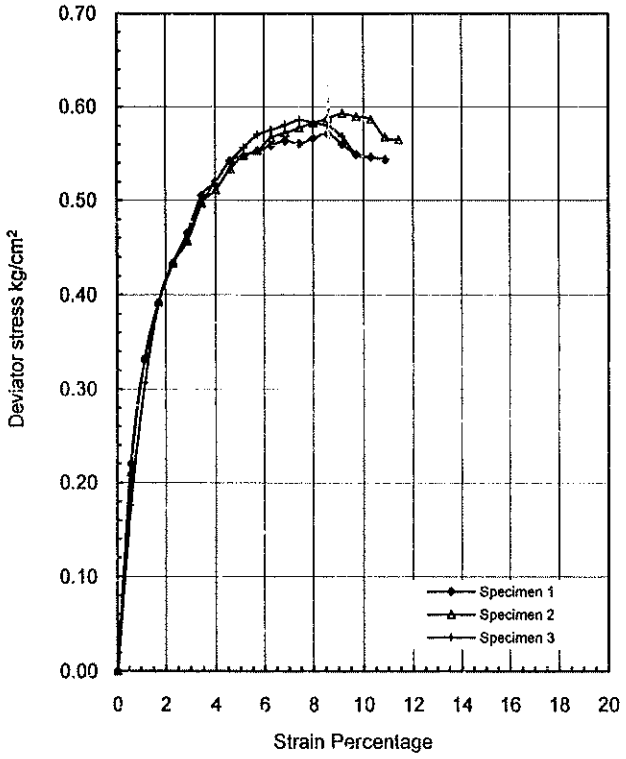


BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/11	2.25m		100.0	97.3	90.7	66.4	25.1		2.7	6.6	24.3	41.3	25.1		SC-SP	0.222	4.332	0.663
BH/11	3.00m		100.0	93.9	85.4	60.9	22.4		6.1	8.5	24.5	38.5	22.4		SC-SP	0.271	5.646	0.637

GEOTECHNICAL Solutions, Chennai

ANNEXURE U-1

Unconfined Compression Strength Test UCC on soil sample



Project:

TNSCB, Perambakkam, H Block

Date of Test	**26-Mar-13**
Borehole	**BH/1**
Depth	**1.50m**

Soil

Greenish grey silty clay with reddish brown patches

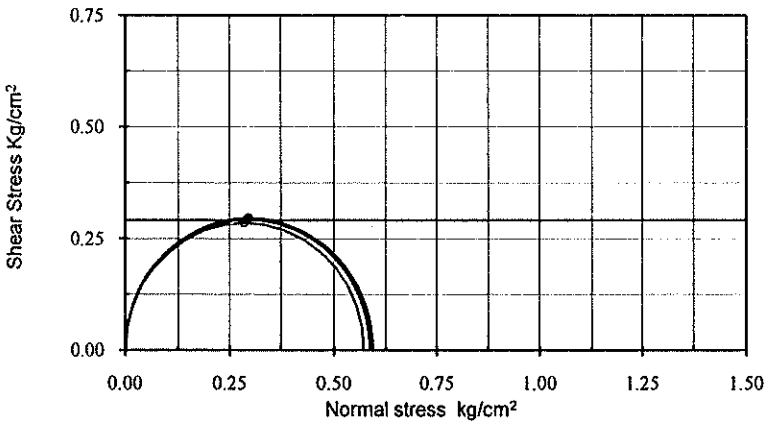
Insitu bulk density	1.757 gm/cc
Insitu Dry Density	1.214 gm/cc
Water Content	44.73 %
Liquid Limit %	92.00
Plastic Limit %	25.20
Plasticity Index %	66.80
Liquidity Index	0.29

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm²
Specimen 1	0.571	0.286
Specimen 2	0.593	0.296
Specimen 3	0.586	0.293

Results

Unconfined compression strength q_u	0.583	kg/cm²
Undrained Cohesion c_u	0.292	kg/cm²
Secant Modulus (undrained)	35.48	kg/cm²



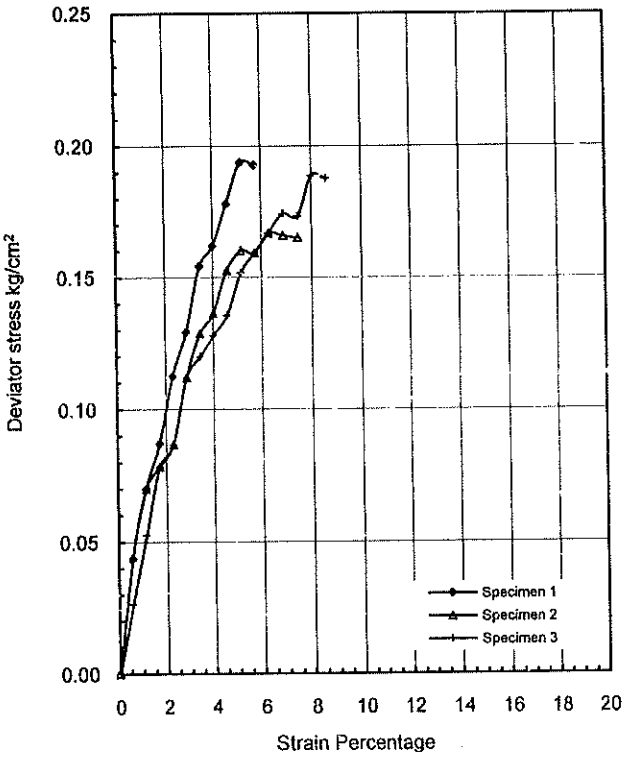
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ANNEXURE U-2

Unconfined Compression Strength Test UCC on soil sample

Project:
TNSCB, Perambakkam, H Block

Date of Test **26-Mar-13**
Borehole **BH/2**
Depth **1.50m**



Soil
Light brownish grey soft silty clay with reddish brown patches

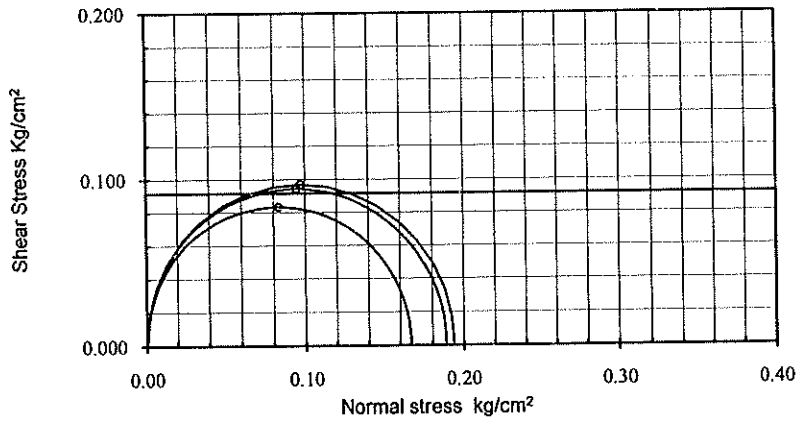
Insitu bulk density	1.636 gm/cc
Insitu Dry Density	1.020 gm/cc
Water Content	60.34 %
Liquid Limit %	86.10
Plastic Limit %	22.40
Plasticity Index %	63.70
Liquidity Index	0.60

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm²
Specimen 1	0.194	0.097
Specimen 2	0.167	0.083
Specimen 3	0.189	0.094

Results

Unconfined compression strength q_u	0.183 kg/cm²
Undrained Cohesion c_u	0.092 kg/cm²
Secant Modulus (undrained)	4.41 kg/cm²



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ANNEXURE U-3

Unconfined Compression Strength Test UCC on soil sample

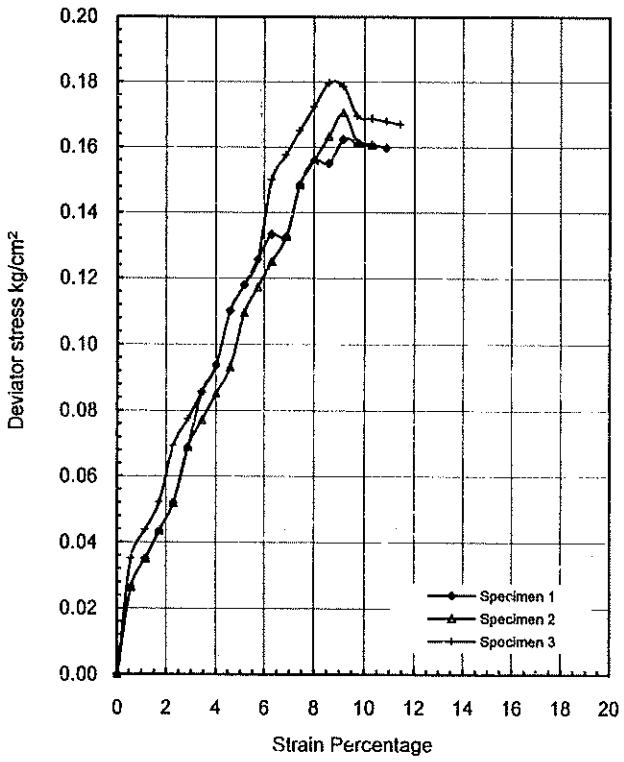
Project:

TNSCB, Perambakkam, H Block

Date of Test **3-Apr-13**
Borehole **BH/12**
Depth **1.50m**

Soil
Greyish soft silty clay

Insitu bulk density	1.652 gm/cc
Insitu Dry Density	1.086 gm/cc
Water Content	52.12 %
Liquid Limit %	46.70
Plastic Limit %	15.80
Plasticity Index %	30.90
Liquidity Index	1.18

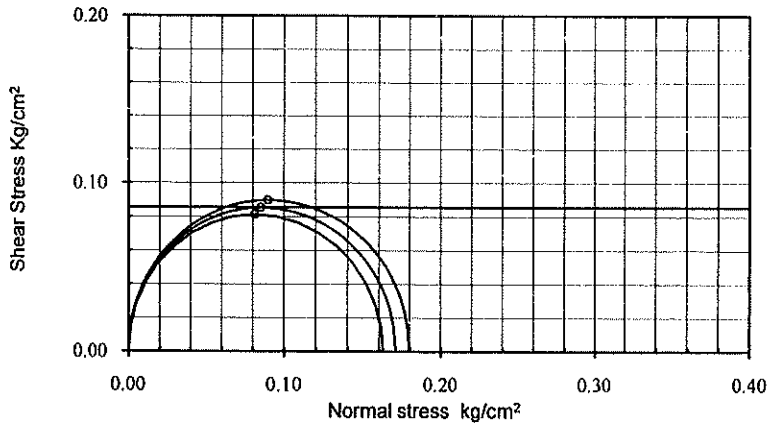


Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm²
Specimen 1	0.162	0.081
Specimen 2	0.171	0.085
Specimen 3	0.180	0.090

Results

Unconfined compression strength q_u	0.171 kg/cm²
Undrained Cohesion c_u	0.085 kg/cm²
Secant Modulus (undrained)	2.33 kg/cm²



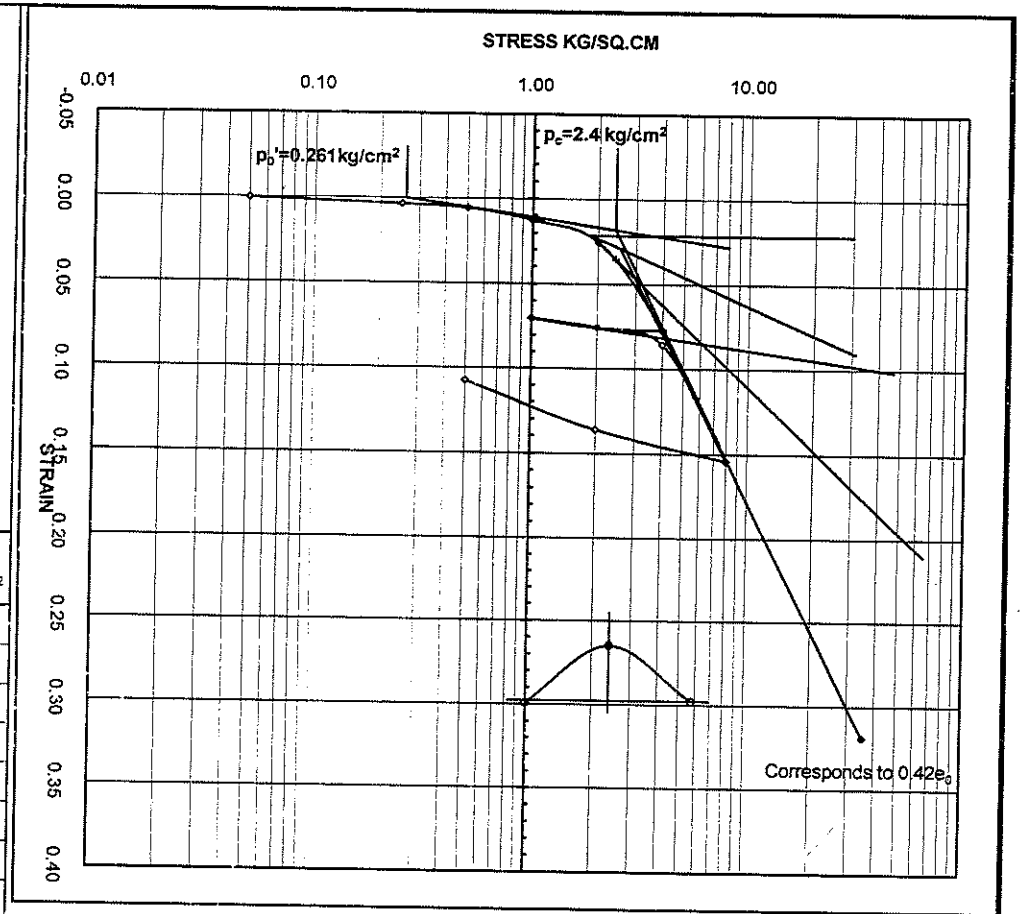
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ANNEXURE C-1

Wt of Consolidation Ring gm :	182.27	Diameter of ring mm :	59.85
Wt of Ring + wet Soil gm :	276.09	Height of ring mm :	19.27
Wt of Wet Soil gm :	93.82	Volume of Ring :	54.23
Wet Density gm/cc :	1.730	Specific Gravity :	2.610
Wt of Wet Soil after test gm :	91.43	Initial Void Ratio :	1.221
Wt of ring + Dry Soil gm :	245.99	Moisture Content % :	47.24
Wt of Dry soil gm :	63.72	Moisture after Test :	43.49
Dry Density gm/cc :	1.175	Height of Solids mm :	8.67
Liquid Limit %	92.00	Saturated Moisture %:	46.80
Plastic Limit %	25.20	Per cent Saturation :	100.94
Plasticity Index	66.80		
Liquidity Index	0.330		

Range of m_v cm^2/kg	from	to
	0.008	0.026

Stress kg/cm^2	Dial div	Incr div	Comp mm	Strain	Height mm	Void ratio	T_{90} min	C_v m^2/yr	Δ_p kg/cm^2	m_v cm^2/kg	E_c kg/cm^2
0.00	2884	0	0.000	0.000	19.27	1.221	_	_	_		
0.05	2879	5	0.010	0.001	19.26	1.220	_	_	0.05	0.010	96.3
0.25	2848	36	0.072	0.004	19.20	1.213	_	_	0.20	0.016	62.2
0.50	2828	56	0.112	0.006	19.16	1.209	_		0.25	0.008	120.4
1.00	2761	123	0.246	0.013	19.02	1.193	16.2	2.51	0.50	0.014	71.9
2.00	2641	243	0.486	0.025	18.78	1.165	44.9	0.89	1.00	0.012	80.3
4.00	2143	741	1.482	0.077	17.79	1.051	143.0	0.26	2.00	0.026	38.7
1.00	2210	674	1.348	0.070	17.92	1.066	_	_	_	_	_
4.00	2060	824	1.648	0.086	17.62	1.031	34.3	1.03	3.00	0.005	192.7
8.00	1401	1483	2.966	0.154	16.30	0.880	104.9	0.31	4.00	0.017	58.5
2.00	1570	1314	2.628	0.136	16.64	0.919	_	_	_		
0.50	1848	1036	2.072	0.108	17.20	0.983	_	_	_		
0.00	2166	718	1.436	0.075	17.83	1.056	_	_	_		



Compression Ratio CR =	0.2576	ONE DIMENSIONAL CONSOLIDATION TEST RESULTS		
Re-compression ratio RR =	0.0197	PROJECT Perambakkam, H Block		
Effective overburden presure	0.26 kg/cm²	BH NO BH/1	DEPTH 1.50m	strain - log p curve
Pre-consolidation Pressure p_c	2.40 kg/cm²	SOIL Greyish silty clay		
from Casagrande method	2.55 kg/cm²			

521

70

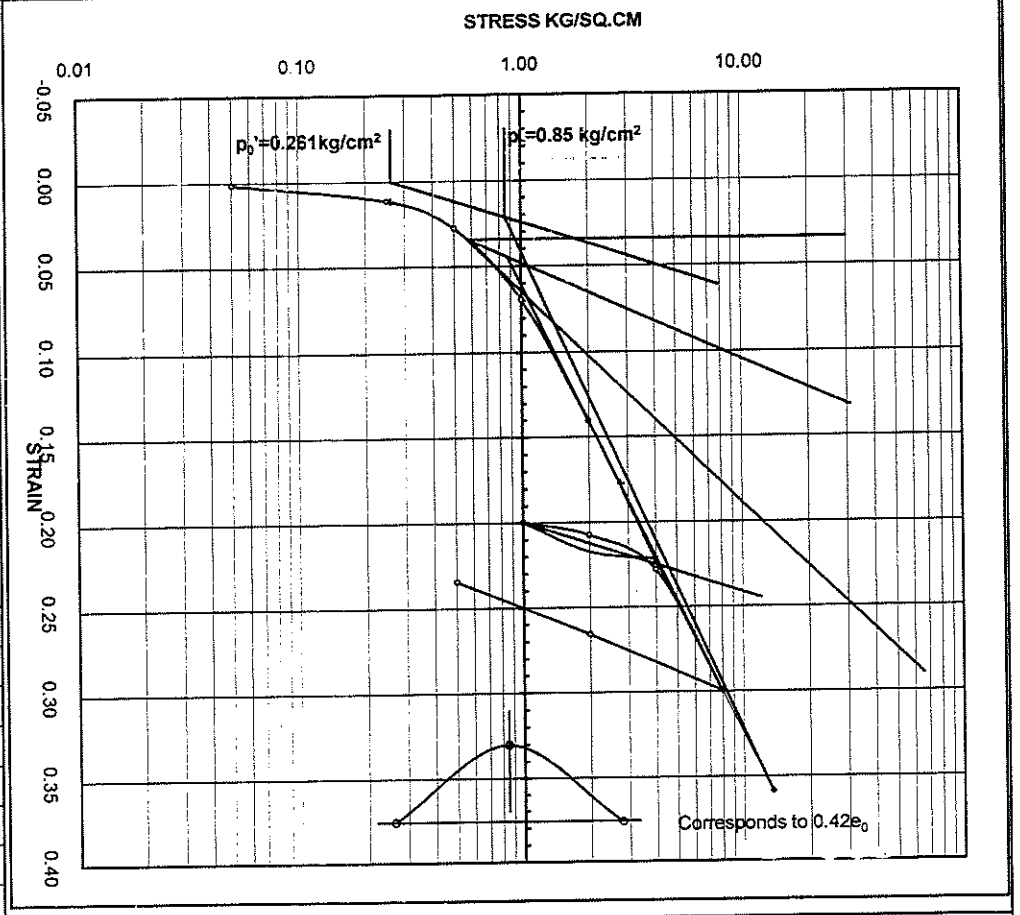
Dept. of Civil Engg.

ANNEXURE C-2

Wt of Consolidation Ring gm :	185.19	Diameter of ring mm :	59.85
Wt of Ring + wet Soil gm :	273.38	Height of ring mm :	19.33
Wt of Wet Soil gm :	88.19	Volume of Ring :	54.39
Wet Density gm/cc :	1.621	Specific Gravity :	2.620
Wt of Wet Soil after test gm :	78.39	Initial Void Ratio :	1.619
Wt of ring + Dry Soil gm :	239.59	Moisture Content % :	62.11
Wt of Dry soil gm :	54.40	Moisture after Test :	44.10
Dry Density gm/cc :	1.000	Height of Solids mm :	7.38
Liquid Limit %	86.10	Saturated Moisture %:	61.81
Plastic Limit %	22.20	Per cent Saturation :	100.49
Plasticity Index	63.90		
Liquidity Index	0.625		

Range of m_v cm^2/kg	from	to
	0.018	0.083

Stress kg/cm^2	Dial div	Incr div	Comp mm	Strain	Height mm	Void ratio	T_{90} min	C_V m^2/yr	Δ_p kg/cm^2	m_v cm^2/kg	E_C kg/cm^2
0.00	5432	0	0.000	0.000	19.33	1.619	_	_	_		
0.05	5418	14	0.028	0.001	19.30	1.616	_	_	0.05	0.029	34.5
0.25	5320	112	0.224	0.012	19.10	1.589	_	_	0.20	0.051	19.7
0.50	5162	270	0.540	0.028	18.79	1.546	_		0.25	0.065	15.3
1.00	4763	669	1.338	0.069	17.99	1.438	44.9	0.84	0.50	0.083	12.1
2.00	4077	1355	2.710	0.140	16.62	1.252	83.5	0.40	1.00	0.071	14.1
4.00	3291	2141	4.282	0.222	15.04	1.039	107.3	0.26	2.00	0.041	24.6
1.00	3502	1930	3.860	0.200	15.47	1.096	_	_	_	_	_
4.00	3231	2201	4.402	0.228	14.92	1.023	36.5	0.70	3.00	0.009	107.0
8.00	2539	2893	5.786	0.299	13.54	0.835	122.5	0.18	4.00	0.018	55.9
2.00	2863	2569	5.138	0.266	14.19	0.923	_	_	_		
0.50	3168	2264	4.528	0.234	14.80	1.006	_	_	_		
0.00	4084	1348	2.696	0.140	16.63	1.254	_	_	_		



Compression Ratio CR =	0.2805	ONE DIMENSIONAL CONSOLIDATION TEST RESULTS	
Re-compression ratio RR =	0.0414	PROJECT Perambakkam, H Block	
Effective overburden presure	0.26 kg/cm²	BH NO BH/2	DEPTH 1.50m
Pre-consolidation Pressure p_c	0.85 kg/cm²	SOIL Greyish silty clay	strain - log p curve
from Casagrande method	0.88 kg/cm²		

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ANNEXURE CS-1

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, HIG, Perambakkam

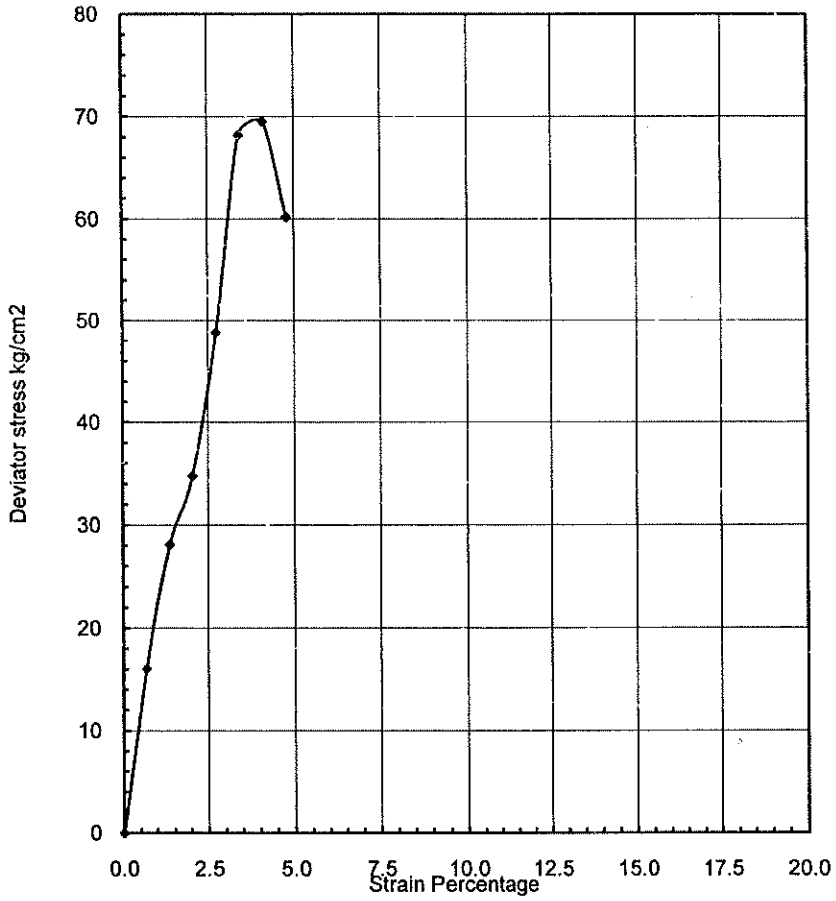
Date of Test	**22-Apr-13**
Borehole	**BH/3**
Depth	**7.00m to 8.00m (S1)**

Description
Greyish jointed rock

Insitu bulk density	2.807 gm/cc
Insitu Dry Density	2.689 gm/cc
Water Content	4.39 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2	
Specimen 1	0.0	70.0	Failed at vertical joint



Results	
Unconfined compression strength q_u	70.0 kg/cm^2
Young's Modulus (secant)	1692 kg/cm^2

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ANNEXURE CS-2

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, HIG, Perambakkam

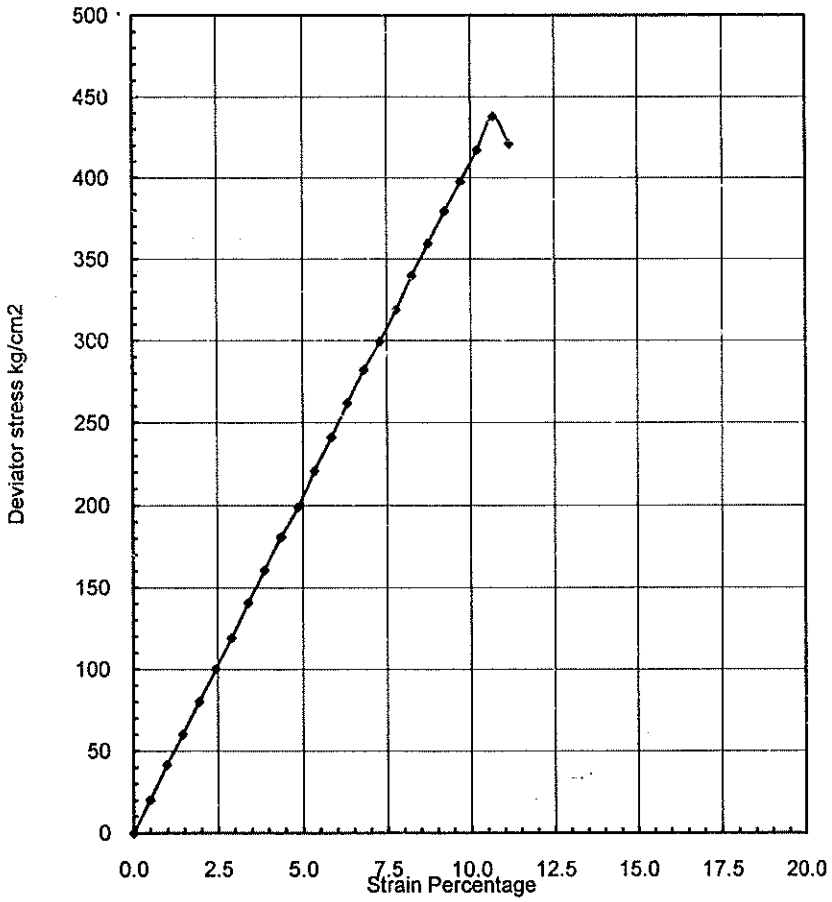
Date of Test	**22-Apr-13**
Borehole	**BH/5**
Depth	**7.00m to 8.00m (S2)**

Description
Greyish granitic hard rock with joints

Insitu bulk density	2.852 gm/cc
Insitu Dry Density	2.781 gm/cc
Water Content	2.53 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	438.0



Results	
Unconfined compression strength q_u	438.0 kg/cm^2
Young's Modulus (secant)	4132 kg/cm^2

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ANNEXURE CS-3

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, HIG, Perambakkam

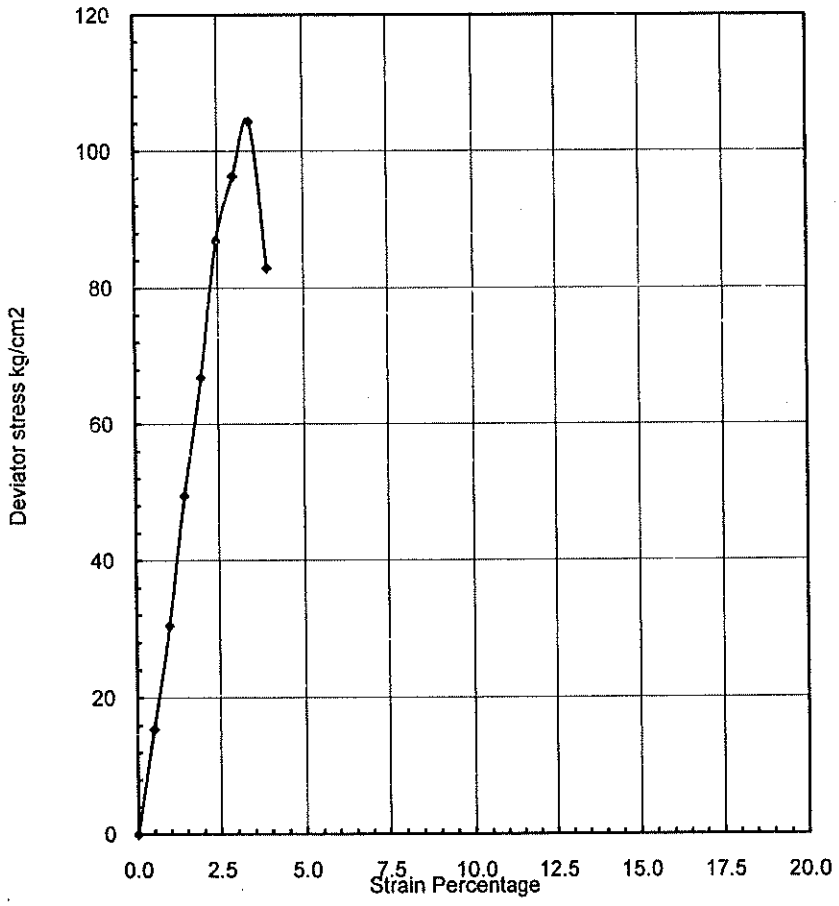
Date of Test	**22-Apr-13**
Borehole	**BH/6**
Depth	**7.20m to 8.20m (S1)**

Description
Greyish jointed rock

Insitu bulk density	2.840 gm/cc
Insitu Dry Density	2.764 gm/cc
Water Content	2.73 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2	
Specimen 1	0.0	104.0	Failed at vertical joint



Results	
Unconfined compression strength q_u	104.0 kg/cm^2
Young's Modulus (secant)	3364 kg/cm^2

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ANNEXURE CS-4

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, HIG, Perambakkam

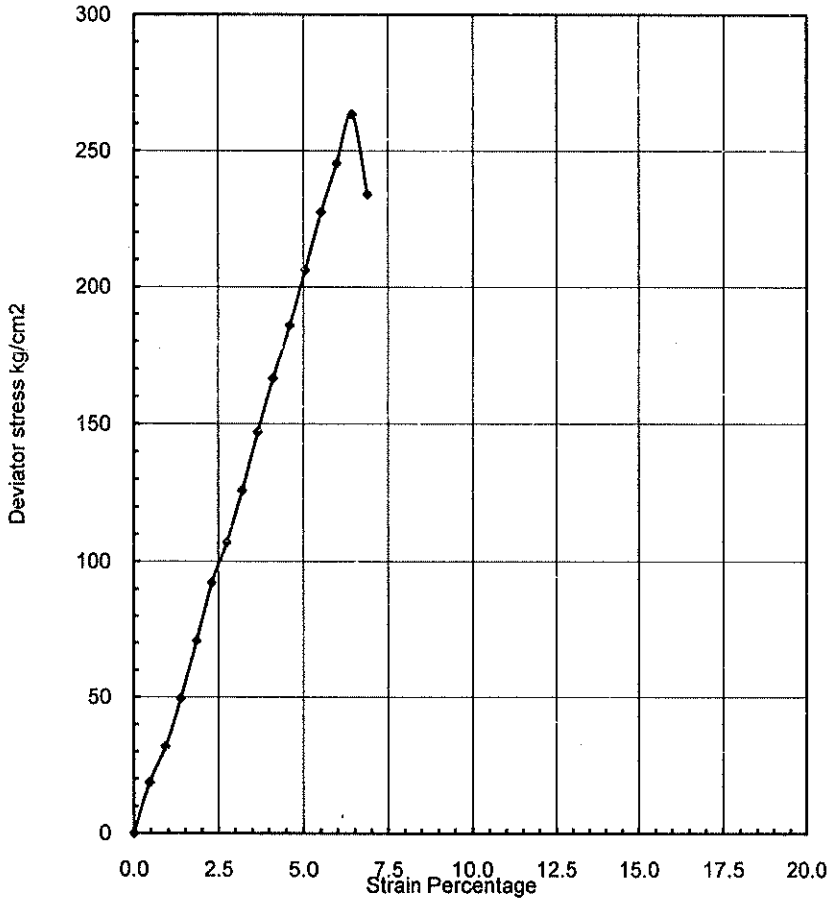
Date of Test **22-Apr-13**
Borehole **BH/8**
Depth **7.00m to 8.00m (S1)**

Description
Greyish jointed rock

Insitu bulk density 2.932 gm/cc
Insitu Dry Density 2.844 gm/cc
Water Content 3.07 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	263.0



Results

Unconfined compression strength q_u	263.0 kg/cm^2
Young's Modulus (secant)	3595 kg/cm^2

ANNEXURE CS-5

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, MIG, Perambakkam

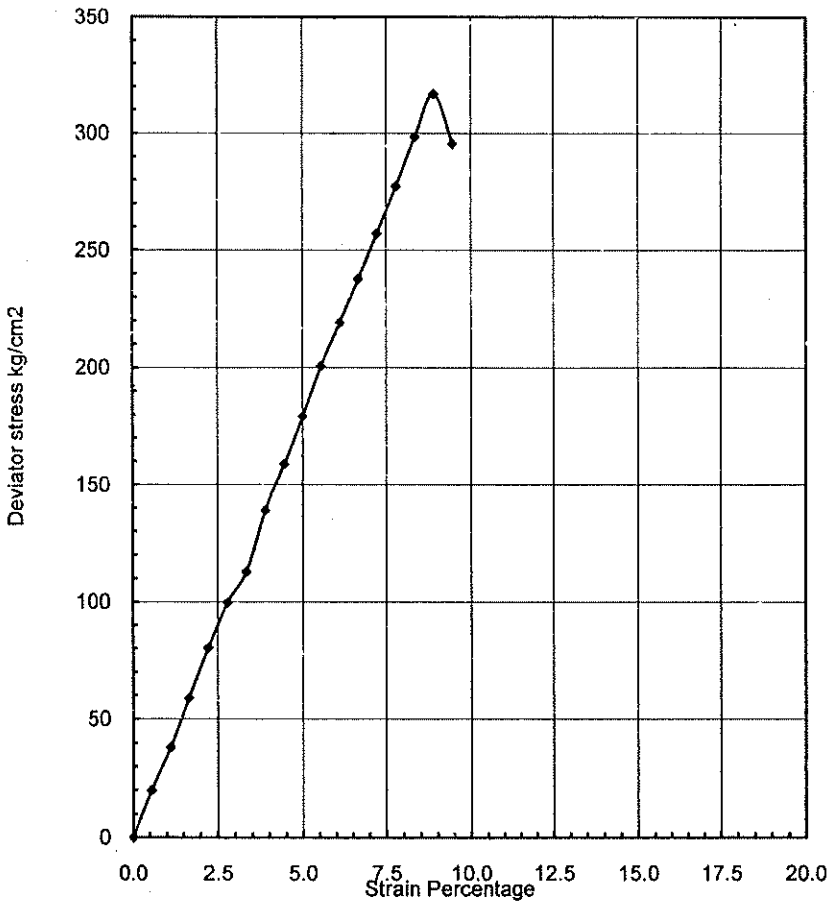
Date of Test	**22-Apr-13**
Borehole	**BH/11**
Depth	**5.40m to 6.40m (S1)**

Description
Greyish jointed hard rock

Insitu bulk density	2.866 gm/cc
Insitu Dry Density	2.810 gm/cc
Water Content	1.97 %

Maximum Shear Stress

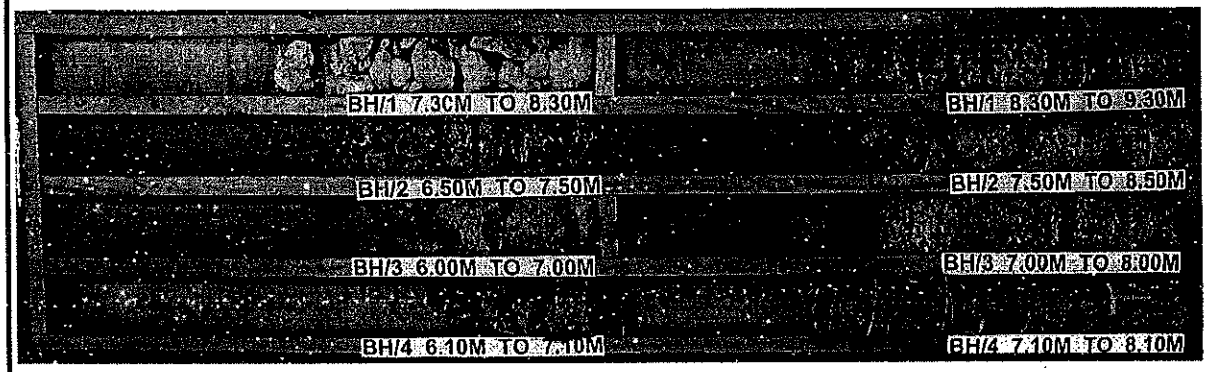
Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	317.0

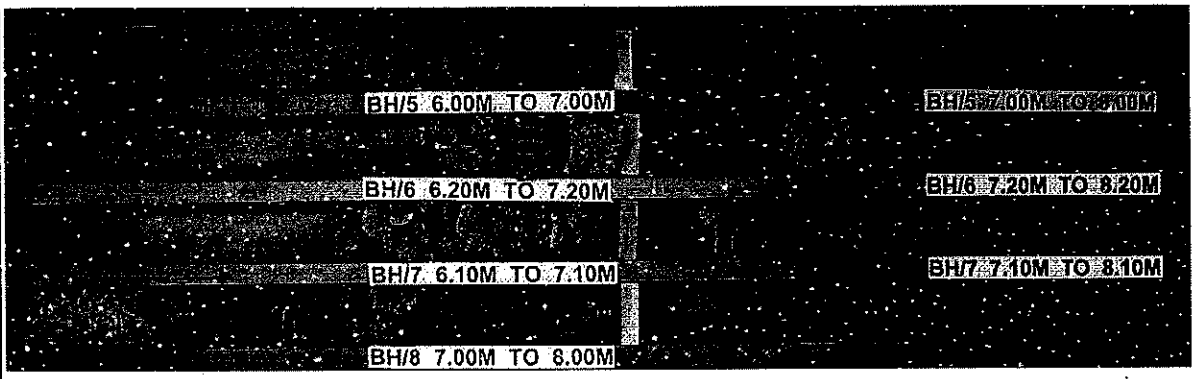


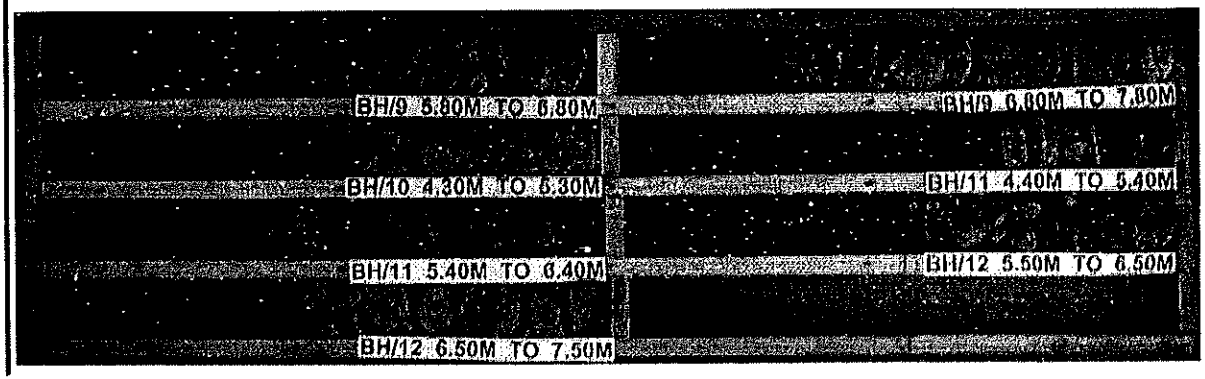
Results	
Unconfined compression strength q_u	317.0 kg/cm^2
Young's Modulus (secant)	3530 kg/cm^2

PLATE 1 CORE SAMPLES FROM BH1 to BH12

CORE SAMPLES FROM BH/1 to BH/12
HIG TENEMENTS, TNSCB, PERAMBAKKAM







Dept. of Civil Engg., Anna University, Chennai-25

REPORT ON SOIL INVESTIGATION AND RECOMMENDATION ON FOUNDATION FOR THE CONSTRUCTION OF STILT+8 STOREYED MIG FLATS AT ZONE 'M2' OF PERUMBAKKAM PROJECT

Job No: SF/KI-48/ Perumbakkam/Zone 'M2'/TNSCB/2013

Client: The Executive Engineer,
ETRP (C-II) Division, TNSCB
Semmenchery, Chennai-600 119.

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4.	Site condition	7
5.	Details of soil investigation	7
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Project Coordinator
&
Professor and Chairman (Civil)

REPORT ON SOIL INVESTIGATION AND RECOMMENDATION ON FOUNDATION FOR THE CONSTRUCTION OF STILT+8 STOREYED MIG FLATS AT ZONE 'M2' OF PERUMBAKKAM PROJECT

Job No: SF/KI-48/ Perumbakkam/Zone 'M2'/TNSCB/2013

Client: The Executive Engineer,
ETRP (C-II) Division, TNSCB
Semmenchery, Chennai-600 119.

1. Introduction

The Executive Engineer, ETRP (C II) Division of TNSCB has sent a request to conduct soil investigation in their housing project site at Perumbakkam TNSCB scheme area through Lr.No:203/E.C/ETRP CII/2012, dt: 03.01.2013 for the construction of MIG and FIG Flats. The Board proposed to construct residential flats in their housing scheme area as detailed below:

Sl.No	Detail	Number of blocks	Area of each unit (m^2)	Number of units
1.	MIG Flats (Stilt + 8 Floors)	12 (64 units in block each)	73.9	768
2.	FIG Flats (Stilt + 8 Floors)	4 (64 units in each block)	97.3	256

To construct these residential blocks an area of 7.13 Hectares is allotted covering survey Nos: 539/2, 540/1, 540/2 and part of 537. The area earmarked for the said purpose is shown in key map (Fig.1a) of the TNSCB Perumbakkam scheme. The proposal of the Board comprises of building nine storeyed (Stilt + 8 floors) framed structures. The Perumbakkam village is located at a distance of about a kilometer

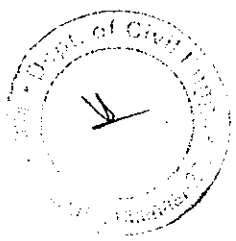
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towards western direction from OMR. A road of 18m wide is connecting this village with OMR. On the Southern side of this road and adjacent to existing TNSCB scheme at Semmencherry, the Executive Engineer (Div VI) of TNSCB executed similar project over an area of 30 Acres covering S.Nos: 542 to 544 during 2009. At this area eight storied framed structures were constructed and they are ready for occupation. These buildings are supported on raft foundation and the depth of foundation of all the buildings is around 4m. The Fig A1 shows the land allotted for the proposed construction including the area where project is completed.

On allocation of land by the Government The Executive Engineer (Div.II), TNSCB took initiative to implement the project and requested the services of Department of Civil Engineering to conduct Soil Investigation for the construction of Block 12 to 18 (S.No: 528) and constructions of Blocks covering area coming under S.Nos:479/2 and 482 to 485. These two locations are marked as Zone 'A 'and Zone 'B' in layout plan (Fig A1) and they lie in the south and north west part of the land allotted for the project.

At Zone 'A' investigation was conducted at 5 locations during April 2010. The top layer is expansive clay of 1.5m thick followed by clayey sand of 1m. Weathered rock was met at the depth of 2.75m invariably and fairly good rock was seen at depth around 4m. The water table was met at the depth of 2.5m. Based on the soil condition of the area, it was recommended to adopt raft foundation at the minimum depth of foundation of 3m (RL -1.45m).

At Zone 'B' investigation was carried out during the second week of June 2010 by drilling eight boreholes. The deposit of this area composed of highly plastic clay of 2m to 2.7m thick followed by residual soil (weathered rock reduced to soil) of 1m to 1.5m thick. However the deposit below 4.5m was fractured rock. At this area the water table was at the depth of 3m. The foundation recommended for the eight storeyed structures was raft foundation and minimum depth of foundation was 2.75m (i.e. RL -1.35m) from the lowest ground level. Recommended bearing capacity was 200kN/m^2. The board commenced the construction work at Zone 'A' and 'B' in the second week of May 2012.



In the remaining part of allotted land of Perumbakkam village, the Executive Engineer, JNNURM Division sent a request through Lr.No:171/JNNURM Dn/A1/2011, dt:28.3.2012 to inspect and conduct subsurface investigation covering survey nos: 509,510,511,516,517,518,536,537 & 538 for the construction of eight storeyed residential block in these location. Accordingly investigation was conducted at 40 locations covering 125 acres of land. Since the area was large, it was divided conveniently in to Zone 'C', Zone 'D', Zone 'E' and Zone 'F' as indicated in Fig A1.

The sub-surface investigation in all these areas was commenced on 25th April 2012 and completed on 19th May 2012. The report was released for each zone independently. The recommended foundation was raft for the eight storeyed buildings irrespective of the Zones in which buildings are proposed to locate. The recommended depth of foundation at different Zones is as below:

Zone	RL of Foundation (m)	Bearing capacity
C	between – 1.0m and -1.2m	220kN/m^2
D	between – -1.9m and -2.6m	220kN/m^2
E	between – -1.1m and -1.6m	220kN/m^2
F	between – 0.9m and -1.2m	220kN/m^2

Foundations of buildings were located at depths as recommended without difficulty except one or two blocks. As stated in the first paragraph of the report the board has drawn a proposal to construct MIG and HIG Flats in this area for the public, since the area lies within a distance of 2km from OMR and demand for house is more in this area.

The board has earmarked the area for this proposal, which lies in the south east part of the Perumbakkam scheme, which is about 7.13 Hectares. The project site was inspected along with the Executive Engineer of ETRP Division and other officials on 28.02.2013. Since the project area is large (total extent is 7.13 Hectares) the buildings are nine storeyed framed structure and this area comes under zone III as per IS1893-2002(Part-1), it is decided to investigate over entire area covering all the 16 blocks. At the end of investigation it is proposed to explore at two locations for each MIG block and at three locations for each HIG block. This proposal is been accepted by the Executive Engineer.

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Accordingly locations of boreholes for each block were selected and mutually agreed to investigate at 36 locations as detailed below:

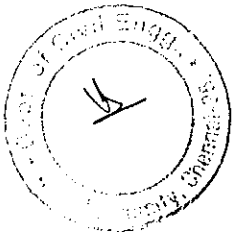
Zone	Number of Blocks	Boreholes
M1	M1 to M6	BH1 to BH12
M2	M7 to M12	BH13 to BH24
H	H1 to H4	BH1 to BH12

Since large part of Perumbakkam Housing Project area was covered in earlier investigation and over all soil condition of this area is known to consultant. In this area, the hard stratum with good bearing resistance occurs within a depth of 4.5m; therefore it is felt sufficient to investigate to a depth of 9m. However one or two boreholes were drilled beyond the depth of 9m to know relative degree of weathering of rock deposit and its quality. The soil investigation work in all the three zones is commenced on 04.03.2013 simultaneously and completed on 9.4.2014.

2. Details of the project

The project to be executed in this area is construction of multi-storeyed blocks for the middle and high income group people under Rajiv Awas Yojana scheme. In this project the Board is proposed to construct 9 storeyed (Stilt + 8 Floors) framed structure by adopting two different type design; one is for MIG and the other is for HIG. Apart from construction of residential buildings they develop other amenities like club house, Gym, Park etc. However the soil investigation carried out is found mainly for the construction of multi-storeyed buildings. Each block of MIG is designed to accommodate eight families in each floor with plinth area of 73.9m^2/ family. Similarly the HIG flats are also designed to accommodate eight families in a block with plinth area of 97.3m^2/unit.

The structure is nine storeyed building and the area of construction is located within 20km distance from Chennai. The Chennai and its neighboring areas is coming under Zone III, hence the structure of this area is to be designed for Zone III conditions. Moreover in the recent past Chennai has experienced mild tremors and the earthquakes occurred in Sumatra islands and Pondicherry coast also felt in some parts of Chennai.



Therefore the board has analyzed the building for the Zone III condition. The minimum and maximum load at the foundation level for the critical load combination was reported as 869kN and 1890kN respectively. Since the soil is in the heterogeneous condition and in hard layer (i.e. weathered rock) clay lumps are seen during investigation, which is not conducive for isolated footing. Therefore the average load at the foundation level for the raft was obtained for the critical combination of load, which is 219kN/m^2.

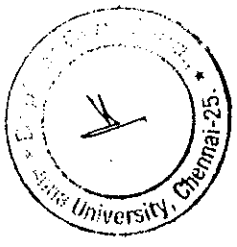
3. Preliminary Inspection of the project area

Perumbakkam area has experienced fast development within a period of four years. The land of Perumbakkam area covering survey numbers as per the key plan (Fig. 1a) was occupied by the local people of the area. This entire area was covered with thatched roof houses, semi permanent and permanent buildings. The local town Panchayat laid temporary roads and provided water and power connections to the houses. Certain houses were provided with soak pits and were connected to toilets. These soak pits are 3.5 to 4m deep from the existing ground level. The area identified for the development of project is covered by 18m road on the south, compound wall of Bollini Hill Housing complex on the west, open private land on north and proposed PWD Drain of 40m wide on the east. This area is at a distance of approximately 2km from the OMR. The ground level of this area though it appears uniform, it is slopping from west to north east direction. The construction of multi-storeyed buildings in this project area was commenced during 2010 in Zone A and covered most part of the area part by part. The part of land, on the south east side of the area covering S.Nos: 537, 539/2, 540/1, 504/2, 541 is vacant and is been identified for the construction of multi-storeyed flats. This area lies within the boundary of 18m wide Semencherry-Perumbakkam road on the south; 30m wide road and PWD drain are on the east, Zone D on north and community facilities of Zone A on the west. The total area is 71330m^2. The ground level of this area is almost uniform and is also free from shrubs and old structures; hence the site is ready for soil investigation. There is a mountain at a distance of about a kilometer or more on the western side and the ground is slopping from the foot of the hill towards east. At the

proposed construction site the ground level is the lowest while comparing with the ground level of neighboring areas. This area is prone for water logging hence the board is proposed to raise the existing ground level.

As stated in the introduction, the area of Perumbakkam (Zone A to Zone F) was already investigated at different pint of time for the purpose of locating suitable depth for foundation of eight storeyed structures and reported occurrence of hard stratum invariably at the depth below 4.5m and the weathered residual soil at depth of around 2.75m. The weathered residual soil was in hard/dense condition with N values more than 50 blows. However on the east and north east part of the area (Zone D) the deposit over a depth of 3m is soft. Keeping this in mind, it is proposed to investigate up to the depth of occurrence of hard stratum (N>100) at all the 36 boreholes. In a few boreholes rock drilling using single tube core barrel with diamond cutter is also recommended in order to confirm the presence of true hard stratum to a reasonable depth. The officials of TNSCB have agreed for this suggestion and proceeded accordingly.

Since the soil condition at major part of Perumbakkam project area is known from the earlier subsurface investigation carried out for the blocks at Zone 'A' to zone 'F' it is agreed mutually by the consultant and the officials of TNSCB to restrict the number of investigation points as minimum as possible. Since buildings are located as clusters accommodating other amenities for each cluster, it is decided to group at each cluster as individual zone. Thus there are three zones (M1,M2&H) and is mutually agreed to investigate at 12 points in each zone by distributing minimum of two exploratory points for each block. The subsurface investigation at the proposed construction area was commenced during the fourth week of February 2013. At all the borehole locations, the borehole was advanced using rotary drilling technique and standard penetration tests were conducted in each borehole at spacing of 0.75m using standard split spoon without liner as per IS2731-1972. The subsurface investigation work in this area was executed by M/s. Geotechnical solutions, Chennai under my (Prof.K.Ilamparuthi, Professor and Chairman, Faculty of Civil Engineering) supervision. This report presents salient details of



investigation and soil type encountered along with recommendation on foundation for the Zone M2.

4. Site condition

The topography of Zone 'M2' is almost uniform and if at all any difference in the levels within the area of investigation may not be more than 0.5m. The deposit on the surface exhibited honey comb pattern tension cracks, which confirm that the top soil is dominantly clay with shrink and swelling quality. Further there is a mountain at a distance about a kilometer or more from the western boundary of proposed construction area. It provides the clue that the rocky stratum will be at a shallow depth in the construction area and the soil cover that lies above is certainly residual deposit. However there is a chance for transported soil deposit on the surface since the ground is slopping from mountain on the west to canal on the east and the ground level is lower in this zone.

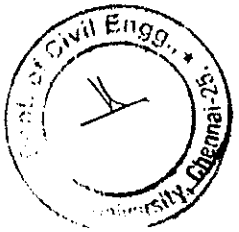
5. Details of soil investigation

At Zone 'M2' soil investigation was carried out at 12 locations as shown in Fig.1b. It can also be seen that the locations of various blocks. The details of borehole locations and the ground level at each location are presented below:

Bore hole No	Identification	Location	Ground level (RL)	Water Table (RL)
1	BH13	Block M7	+1.688m	+0.288m
2	BH14	Block M7	+1.415m	+0.051m
3	BH15	Block M8	+1.339m	+0.039m
4	BH16	Block M8	+1.240m	+0.140m
5	BH17	Block M9	+1.492m	+0.092m
6	BH18	Block M9	+1.409m	+0.009m
7	BH19	Block M10	+1.409m	+0.109m
8	BH20	Block M10	+1.250m	+0.150m
9	BH21	Block M11	+1.354m	+0.154m
10	BH22	Block M11	+1.267m	+0.267m
11	BH23	Block M12	+1.200m	+0.200m
12	BH24	Block M12	+1.295m	+0.295m

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The boreholes were made to collect information on nature of overburden and depth of occurrence of hard stratum. They were drilled using rotary method with bentonite mud circulation. This method is normally adopted to advance the boreholes both in residual and sedimentary deposit. The circulation of drilling fluid was employed through drill rods and letting out through the jets provided in the cutting tool. The jetting action with pressure flow brings the cut material to the surface through the annular space between the sides of boreholes and drill rod. Boreholes of diameter 150mm were drilled by adopting this method. During drilling it was ensured that the borehole was kept full with drilling fluid to avoid disturbance to the sides as well as bottom heave. In the boreholes, standard penetration tests were conducted at required depth or wherever there was a change in the soil layer. This test was conducted using standard dimension split spoon without liner as per the procedure given in IS 2731-1972 using donut type hammer dropped mechanically (2 turns of rope in the cathead arrangement). The energy of impact was around 70%. Thus the field value was N_{70}. However the filed N values were corrected for the installation procedure and the value was very close to N_{60}. Therefore recorded values were taken as N_{60}. The values thus recorded were not corrected for overburden since the top soil to the depth of 2.5m was having fines more than 50%. Further the correction for saturation was also not applied for the resistance values recorded below water table since the deposit was not fine sand. Further the overburden correction factor is greater than unity for the N values recorded at shallow depths; hence the said conditions will certainly result in conservative resistance of deposit. The soil samples obtained from the split spoon were visually identified and tested in the laboratory for assessing index properties. Soil samples collected in split spoon samplers are subjected to test for index properties. The boring and sampling operations were continued at each location until refusal N value (rebound) was recorded or two consecutive N values were grater then 50 blows and the third N value was more than 100 blows. However at locations wherever rock was encountered, exploration was continued using single tube core barrel with diamond cutter. In the rock stratum drilling was done to a depth not less than 1m and obtained core samples. In all the boreholes level of water table was recorded. The depth of



ground water table recorded at various locations is included in the table presented in this section.

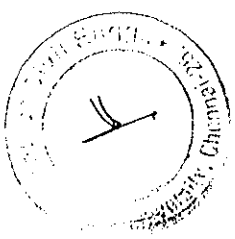
6. Soil profile of the proposed site

The investigation at this area was commenced after marking borehole locations and their reduced levels. The reduced levels of borehole locations are almost uniform at most of the locations except at BH13 and BH23. The difference in level is 0.5m between BH13 and BH23 and the RL at BH13 is +1.688m. As stated in the previous section, the soil profile is logged at each location based on soil samples obtained using split spoon sampler. The profiles thus logged at 12 locations are presented in Figs 2 to 13 along with N values recorded. The field N values recorded are taken as $(N_1)_{60}$ (i.e. design N values) for the reasons already stated irrespective of the depth and nature of deposit of this area.

The disturbed samples of each borehole are tested for index properties inclusive of swell quality. The index properties such as Gradation, Atterberg limits, and Free Swell Index are presented in Table 1 to 12 for the boreholes BH13 to BH24. The gradation curves are presented in Annexure G. The undisturbed samples obtained from the clay layers are tested for strength. The strength is determined from the samples by conducting unconsolidated undrained test at their natural moisture contents and the respective stress-strain responses are present in Annexure-U along with Mohr-Coulomb envelope. The strength and secant modulus are also presented. The compressibility properties of clay deposits are determined from index properties using established empirical equations. The soil deposits logged at each block are presented and discussed below.

Block M7

The block M7 is located on the northwest corner of the Zone M2. At the block M7 two exploratory boreholes (BH13&BH14) were made by locating them diagonally opposite to each other in the northwest and southeast corners of the block. At these two boreholes exploration was done to a depth of 8.3m and 8.7m respectively and the borehole were terminated in severely jointed rock.



The difference in ground level at both the borehole locations is about 0.2m, which shows that the terrain is almost uniform at Block M7. The soil profile logged at BH13 and BH14 is presented in Fig 2 and 3 respectively along with N values recorded.

At BH13 the top layer to a depth of 1.9m is silty clay. This layer recorded a minimum N value of 10 blows at the depth of 0.75m and a maximum value of 25 blows at the depth of 1.5m. This clay layer is in medium stiff to stiff condition and its stiffness is increased with depth. Results of Atterberg limit tests and free swell index show that this layer is high plastic clay (CH) and it possess volume change quality. Its liquid limit and plasticity index are more than 67% and 43% respectively. The deposit between the depth of 1.9m and 5.5m is a residual deposit. In this residual deposit, clay content is about 20% and is classified as SC/SM. This intermediate layer is in dense condition and becomes very dense layer by recording N value > 100 blows. The rock is encountered at the depth of 5.5m, which is highly weathered and further exploration to depth of 8.3m confirms that the rock deposit is becoming strong. However the deposit at the depth of termination is severely jointed with core recovery ratio of 13%, which can be seen from the plate 1 wherein core sample obtain between the depth 7.3m and 8.3, is shown. Thus the deposit at BH13 within the depth of investigation of 8.3m is three layer system comprises of top layer of high plastic clay (CH), intermediate residual deposit of clayey sand (SC/SM) followed by weathered rock.

The BH14 which is been made at the southeast corner of block M7 has also recorded identical soil condition (three layer system) as that of BH13. The top soil to a depth of 2.2m is silty clay. This layer is in medium stiff condition at the depth of 0.75m and is becoming stiff at depth 1.5m. This layer contains plastic clay which is known from the plastic index values of the clay (I_p>61%). Its free swell index values are also more than 67% (Table 2). Thus the soil is clay of high plastic (CH) and is susceptible for volume change. The layer that follows the clay is clayey sand/silty sand with fines in the range of 15% to 30%. The N values recorded in this layer are between 25 and 100 blows, indicating that the layer is dense to vary dense condition. The deposit that lies below the depth of 5.0m is weathered rock; its degree of weathering appears to be the same, which



is known from the recovery ratio of core samples. The recovery ratio of rock core between the depth of 5.0m and 8.7m is between 8% and 15% with nil RQD.

Block M8

The Block M8 is located on the southern side of Block M7. In the location of Block M8 two boreholes (BH15&BH16) were made as shown in Fig.1b. BH15 was made on the northwest corner whereas BH16 was made at the southeast corner of the block. At BH15 exploration was terminated at the depth of 7.6m whereas BH16 was terminated at the depth of 10.2m from the respective ground levels. The ground levels at BH15 and BH16 are +1.339m and +1.24m respectively. The soil profile logged and N values recorded at these two borehole locations are presented in Figs 4&5.

At these two borehole locations top soil to a depth of 2m is silty clay with N values in the range between 8 and 21 blows. The silty clay layer is medium stiff at the depth 0.75m and becomes stiff at 1.5m. Its index test results are presented in Table 3 and 4. It has high liquid limit (between 62% and 88%) and plasticity index values between 43% and 65%, which indicates that the fines of this layer is plastic and the soil is classified as clay of high plastic (CH). The layer that lies below the silty clay layer is clayey sand/silty sand with fines less than 22%. Thickness of this layer is about 1.5m and 2.6m at BH15 and BH16 respectively and is in dense (N>41) to very dense condition (N>100). The weathered rock that lies below residual sand layer is highly weathered and fractured. However the presence of strong layer is confirmed by drilling to a depth of 7.6m at BH15 and 10.2m at BH16. At which depths the deposits are jointed fractured rock. However at BH16 the fractured rock between 8.1m and 9.2m is highly weathered and reduced to fractions of sand and stones. Despite high degree of weathering the deposit is strong (N>100).

Block M9

At Block M9 also exploration was conducted at two locations by locating the boreholes diagonally opposite to each other. The soil profile logged at BH17 and BH18 are presented in Fig 6&7 respectively. The test results conducted on samples of split spoon are presented in Table 5 and 6.

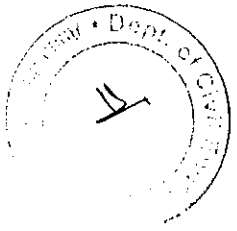


Top layer is silty clay and its thickness is approximately 2.3m at BH17. In this clay layer liquid limit value is more than 58% and FSI values are also more than 55%. These values confirm that the clay layer is active and is susceptible for volume change due to seasonal moisture variation. The N values recorded show that the clay layer is in very soft condition (N= 0). However at BH18 the top clay layer is soft to medium stiff with maximum N value of 8 blows.

The deposit between the depth 2m and 4.5m is residual clayey sand layer with fines between 12% and 25% at BH18. This layer is in medium dense (N=24) to very dense condition. The maximum N value recorded in this layer is 187 blows (extrapolated value) at 3.75m at BH18, which indicates that the stratum is becoming strong. At these two borehole locations weathered rock layer is met at depth approximately 4.5m and presence of rock deposit is confirmed by drilling to an additional depth of 3m. The borehole was terminated at the depth of 9.0m and 8.5m at BH17 and BH18 respectively, at which the rock is silt stone, which is weathered and jointed. The recovery ratio of core samples at the depth of 7.5m is 22%. The RQD of sample is zero. Plate 2 presents the core samples of BH17 and BH18.

Block M10

The Block M10 is located on the south side of Block M9 and at the location of the Block M10 exploration was done by drilling at two points (BH19&BH20) within the area of the block. The borehole 19 (BH19) is drilled at the northeast part of the block whereas borehole 20 (BH20) is drilled at the southwest part. The soil profile logged at both the locations is presented in Figs 8 and 9 along with N values recorded. At BH19 the top soil to a depth of 2.4m is silty clay, which is in soft condition (N≤ 2). The deposit that follows the clay is silty sand of 1.6m thick between the depth of 2.4 and 4.0m. This sand deposit is in dense condition with N values greater than 44 blows. Weathered rock changes to strong (hard) rock at the depth of 6.7m and the core sample obtained between the depth of 6.5m and 7.5m recorded the recovery ratio of 31% and RQD of 28%. These values confirm that the rock occurring at depth below 7m is hard and is classified as stilt stone. The core recovered at depth below 6.5m is shown in plate.2.



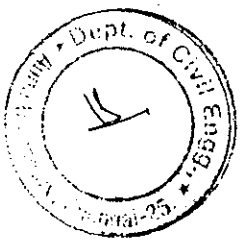
The laboratory test results of samples of clay layer and clayey sand layer are presented in Table 7. The liquid and plastic limits of clay are in the range between 42% and 65% and 13% and 20% respectively. The samples also recorded FSI values more than 70%. Thus clay fines are active and plastic and the soil is classified as clay of high and intermediate plastic (CH and CI). In the silty sand fines are in the range of 14% to 16% and sand fractions are more than 80%. Thus classified as poorly graded sand / silty sand (SP/SM).

The deposits encountered at BH20 are marginally different from BH19, though the overall condition of the deposits is almost identical. The top layer is clay of high plastic (Table 8) as seen at BH19, but its thickness is 2.2m. However the clay layer has almost identical character as that seen in the clay of BH19. The second layer is clayey sand/silty sand, its thickness is about 1.2m and is in medium dense condition at the depth of 2.4m and in dense condition (N>100) at the depth of 3m. The deposit that follows the sand layer is weathered fractured rock and recorded refusal N value at the depth of 3.75m. This stratum continues up to 6.8m, at which depth, the borehole was terminated. The rock deposit available at depth between 3.75m and 6.8m is strong and less weathered since recovery ratio and RQD values are 25% and 25% respectively.

Block M11

Borehole 21 and 22 are made at Block M11 which is located almost at the centre of Zone M2. At BH21 exploration was made to a depth of 8.5m and was terminated in weathered and closely jointed rock. The deposit at this borehole location comprises of soft clay layer of 1.9m thick followed by stiff clayey sand layer of 0.4m thick. The N value recorded in the clay layer is between 2 and 7 blows. In the sand layer the resistance is high (N>44) and recorded refusal condition at the depth of 4.5. The weathered rock that follows the sand is highly weathered and it belongs to silt stone group wherein recovery ratio is between 17% and 19% in the layer between the depth of 5.5m and 8.5m. However the RQD of core samples is zero.

The soil profile logged at BH22 (Fig.11) is almost identical to that of BH21. Top layer is soft clay of 2.6m thick with N value less than 3. This layer is underlain by



organic sandy clay of 0.8m thick with N value zero. However deposit is becoming strong from the depth of 3.4m which is a fine to medium sand. Thickness of this layer is 2.2m and its coarse fraction increases with depth and also becoming very strong by recording N value >100. It is certainly a residual deposit containing weathered stone pieces. The refusal condition is encountered at 5.5m depth where the deposit is highly weathered rock. This layer continues up to 9.7m at which depth the borehole was terminated. The core samples extracted at various depths of this borehole recorded minimum core recovery of zero and maximum core recovery of 19%. The rock available between the depth 6.7m and 8.7m is weak whereas at depth between 8.7m and 9.7m is moderately strong. However the deposit below the depth of 5.5m can be considered as strong bearing layer. The laboratory test results of top clay layer of BH21 and BH22 are presented in Table 9 and 10 respectively. The liquid and plasticity index values are high and its plasticity indices are between 46% and 74%. Free swell index of the clay is between 66% and 175%. Thus the clay layer of BH21 and BH22 is high plastic clay with swelling clay minerals. It is classified as clay of high plastic (CH).

Block M12

At Block M12, exploration was done at two locations as shown in Fig.1b. Borehole 23 (BH23) and borehole 24(BH24) are located diagonally opposite to each other. At BH23 the deposits are soft silty clay followed by silty clayey sand up to 5.5m from the existing ground level followed by weathered rock up to 8.3m, at which depth; the borehole was terminated (Fig 12). The clay layer is in soft condition with minimum and maximum N values of 0 and 3 blows. This layer is classified as clay of high plastic (CH) since liquid and plasticity index values are more than 50% and 43% respectively. The sand layer that follows the clay is classified as clayey sand in which fines are about 22% and sand fractions are more than 60% (Table 11). It is in very dense condition with N value much higher than 100 blows. However there is a decayed wood seam between the depth of 3.15m and 3.45m. Similar organic sandy clay layer is seen at BH22 at depth between 2.6m and 3.4m.The reason for such deposit at these two boreholes is not known, however this formation is problematic deposit and foundation needs to be located below



this deposit. The rock layer that lies below the sand is highly weathered till the depth of 6.3m. However the degree of weathering in rock layer is reduced with depth and core recovery of 8% to 12% is obtained in the rock between the depth of 6.3m and 8.3m.

The deposit encountered at BH24 up to the depth of 2.4m is soft clay as recorded at BH23. But the thickness of residual soil is about 0.4m only in this borehole and weathered rock occurs at depth of 2.75m, which is the highest level of occurrence of rock stratum among the twelve boreholes. The borehole 24 was terminated at the depth of 5.3m, where the deposit was severely jointed rock. The recovery ratios of core samples obtained in this deposit were between 19% and 24%. The clay layer possess same characteristics as that at the clay at BH23 (Table 11) and is classified as CH type clay. The rock layer that lies below the sand is highly weathered till the depth of 6.3m. However the degree of weathering is reduced with depth and core recovery of 19% to 24% is obtained in the rock between the depth of 3.3m and 5.3m.

The overall variation of deposits at locations of each block are combined and presented in Fig 14 to 19 for blocks M7 to M12 respectively. From the figures presented and properties given in tables it is clear that the deposit of the area within the depth of investigation comprises of three layer system. The top layer is clay of high plastic (CH) with liquid limit higher than 60% in general. The swelling quality of the clay is critical to high and is confirmed through the free swell index values more than 60% in most of the samples. Its thickness is found to vary between 1.9m and 2.8m and is in soft condition at most of the locations. The soil of this layer is not even suitable for filling work.

The deposit lies below the clay layer (CH layer) is clayey sand/silty sand. Its thickness is about 3m in general. This layer is in dense condition with recorded N values are close to 50 blows or more except at the transition zone between clay and sand layers. The limitation in this layer is presence of clay lumps, clay patches and organic deposits at certain locations (BH22 & BH23). These lumps are part of highly weathered soil derived from the parent material rock. But the reason for organic deposit is not known. As long as clayey sand layer is intact there may not be change ir their property but due to release in pressure and direct contact with water it will become soft. Thus the condition is not

favorable for isolated footing. Moreover excavation of this layer in presence of water or below the water table will create a problem to locate the foundation in this layer provided the water table is reduced well below so that the soil is not losing its strength and provides good environment for construction. Irrespective of type of foundation, the foundation is to be located below the organic deposit.

The third layer is weathered rock. In this deposit degree of weathering is decreasing with depth and the thickness of strongly weathered portion is around one meter. However the rock stratum at depth below 5.5m is strong deposit however it is, fractured and severely jointed. This rock mass recorded maximum recovery ratio of 31% at BH19 and the RQD is 28%. In general recovery ratio of rock deposit is in the range of 4% to 19% and in most of the locations the RQD is nil. The rock cores obtained from the boreholes are shown in Plate 1 and Plate 2. Rock samples of certain boreholes are tested for strength under unconfined condition and test results are presented in Annexure CS1 & CS2. The unconfined strength of samples is presented below along with secant modulus of samples. The strength of rock of Zone M2 is less than the strength of rock deposit of Zone M1.

S.NO:	Identification	Depth, (m)	Unconfined Strength, (kN/m^2)	Secant Modulus (kN/m^2)
1	BH19	6.5-7.5	7000	314500
2	BH20	5.8-6.8	16400	324200

The properties of various soil layers both strength and compressibility are obtained from the N values using existing correlations and presented in Table 13. In case of clay Terzaghis' relation is used for obtaining undrained cohesion (C_u) values. The values thus obtained are found to vary between $7.5kN/m^2$ and $15kN/m^2$ in soft clay and the values are in the range between $35kN/m^2$ and $75kN/m^2$ in medium stiff to stiff clay. The strength obtained from UCC test on UDS of BH24 (Annexure U1) is $6.4kN/m^2$, which is in comparison with the value of $7.5kN/m^2$ obtained by empirical correlation. In silty sand/clayey sand angle of shearing resistance (ϕ) is obtained using Meyerhof recommendations. However the modification suggested by Houch for the percentage

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fines present in the deposit is applied. The ϕ values obtained are varying between 32° and 42°.

In sand compressibility parameter is obtained by the relation $C=1.9\ q_c/\sigma'_0$, where q_c–cone resistance and σ'_0–effective overburden pressure. This procedure was developed by DeBeer and Martens (1957) and later on modified by Meyerhof to determine the elastic settlement in non plastic cohesionless deposit. IS 8009 (Part I), is also recommends this method to obtain immediate settlement. In the absence of cone resistance (q_c), it is considered equal to 220N to 300N (kN/m^2) since the deposit is SP/SM type. The strength and compressibility parameters thus obtained are summarized in Table 13.

In the absence of consolidation test results, the compressibility parameter, m_v (=1/E) of clay deposit of Zone M2 is obtained from the chart of Stroud (1975) which accounts for the plasticity of clay fines and the value is based on N_{60} value and is equal to 1/F N_{60} (m^2/kN). The "F" is varying between 420 and 480 in medium to stiff clays. The shear strength of rock is obtained from the UCC test conducted on core samples of BH19 and BH20 and the values are $7000kN/m^2$ and $16400kN/m^2$ respectively. The C_u values are also obtained for highly weathered rock based on Cole and Stroud (דרפ) chart and the values thus obtained are presented in Table 13.

7. Ground water quality

The ground water table at all the boreholes is monitored and the levels are reported in section 5. Water samples are collected and tested for pH, sulphates and chlorides. Since the water is brackish, it is also decided to test the soil for above properties. The chemical test results are presented below:

Chemical test results of water and soil samples

Location	Sample	Depth m	pH	Sulphate (SO_4) ppm	Chloride ppm	Remarks
Block M7	water	1.5 (BH13)	7.65	745	15575	Sulphates and chlorides are very high
Block M9		1.5 (BH18)	8.1	875	13450	
Block M7	soil	1.5(BH14)	8.1	350	750	Sulphates and chlorides are high

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In water samples tested, pH is close to neutral, but chlorides and sulphates are very high and the amount of chlorides present in ground water indicates that the ground water of this area is just like sea water.

In soil, the contents of sulphates and chlorides are more in top clay layer. The results of tests on soil and water are to be reconfirmed. Sulphates and chlorides both in soil and water are more than the permissible limits as per IS 456 (Refer Table 4). Since ground water is very poor in quality suitable measure is to be taken to protect concrete and rebars from sulphate attack and corrosion of reinforcement. The clayey soil is not only plastic but also contains chlorides and sulphates in high quantity, hence not suitable for filling.

8. Summary

1. The top soil is highly plastic clay at all the borehole locations. Its thickness is found to vary between 1.9m and 2.8 m. It is susceptible for volume change due to seasonal variation in the moisture content. Free swell index value is as high as 100% at a few locations indicating clay is active. It is in medium stiff to stiff condition at Block M7 and M8 and rest of the locations the clay is in soft state. Native clay soil is not at all suitable for any construction work including back fill of basement and foundations.
2. The deposit below the depth of 2.5m from the existing ground level is residual deposit (highly weathered rock), which is a strong layer. The minimum N value recorded in this layer is 24 blows, which indicates that the deposit is in medium dense state. Further fines are less than 25% in sand at most of the location except at the transition zone between clay and sand and the balance content is dominantly sand and gravel fractions. This layer is strong enough to support any shallow foundation. However presence of clay lumps and clay patches need to be considered while deciding the foundation type. However at two locations sand is

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mixed with organic soil, but this layer is at shallow depth; hence foundation can be located below this layer.

3. The deposit below 5m is highly fractured rock which has recorded refusal N value. The recovery ratio of rock samples found to vary between 0 and 19% at most of the depths of rock deposit, which indicates that the rock is jointed and fractured. However a value of 31% is also recorded at certain depth of rock deposit. RQD is generally zero and more than 25% is recorded in rock samples obtained at depth below 6m at two boreholes located on the south western side of Zone M2. The maximum RQD is 28%, which is recorded in BH19 at the depth between 6.5m and 7.5m.
4. The water table level is at shallow depth (1m to1.4m) from the existing ground level. The lowest level of ground water table at M2 area is +0.009m (RL) during the time of investigation (March 2013). The sulphates and chlorides are present in both soil and water samples.

From the summary presented it is evident that the deposit of area is suitable for providing foundation at shallow depth. However the top soil to a depth of 2.5 to 3.0m is poor, hence foundation cannot be located in this layer. Therefore it is felt essential to locate the foundation at a minimum depth of 3.2 from the existing ground level. The depth suitable to locate the foundation is 3.2m or below from the existing ground level. The maximum variation in the reduced level of borehole locations is 0.5m (maximum + 1.688m and minimum +1.200m); hence minimum level of foundation shall be -2.0m (RL). However depth of foundation for each block of Zone M2 area is given in the Section 10.

9. Selection of foundation

The subsurface condition of deposit of area is very much suitable for shallow foundation except that the foundation needs to be taken below the top clay layer. In this case it is suggested to locate the foundation at a minimum depth of 3.2m from the

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existing ground level. In order to decide the depth of foundation of the blocks, N value more than 50 blows and location of water table are compared as below:

Borehole No:	Block No:	RL of stratum at N>50, (m)	RL of min.Depth of foundation, (m)	WT RL, (m)	Remarks
BH13	M7	-1.462	-1.512	+0.288m	Water table is above the foundation level
BH14	M7	-1.735	-1.785	+0.015m	Water table is above the foundation level
BH15	M8	-1.061	-1.061	+0.039m	Water table is above the foundation level
BH16	M8	-1.910	-1.910	+0.140m	Water table is above the foundation level
BH17	M9	-1.658	-1.658	+0.092m	Water table is above the foundation level
BH18	M9	-1.741	-1.741	+0.009m	Water table is above the foundation level
BH19	M10	-2.491	-1.891	+0.109m	Water table is above the foundation level
BH20	M10	-1.900	-1.900	+0.150m	Water table is above the foundation level
B21	M11	-2.396	-1.946	+0.154m	Water table is above the foundation level
BH22	M11	-3.233	-2.733	+0.267m	Water table is above the foundation level
BH23	M12	-2.550	-2.550	+0.200m	Water table is above the foundation level
BH24	M12	-1.505	-1.505	+0.295m	Water table is above the foundation level

From the comparison made it is clear that foundations are to be located below the water table. The water table level reported is obtained from the borehole during investigation; there is a possibility for variation in the water table level. Therefore it is suggested to ascertain the water table level at each block at least at two corners before proceeding with the work of foundation. Normally the actual water level may be higher than recorded in the boreholes. It is suggested to locate the foundation a few centimeters above the water level in order to avoid excavation below the water table otherwise excavation below water table makes the soil to lose its strength. However at Zone M2



area the foundations are to be located below the water table, hence dewatering is essential.

The bearing capacity and settlement of foundation for the minimum depth of foundation given in the table are determined. The bearing capacity is determined for the raft foundation of size 23mx46m (approximate) using Teng (1961) equation and bearing capacity equation given in IS6403. The allowable bearing pressure is obtained for 25mm settlement using Teng equation and it varies between 358kN/m^2 and 403kN/m^2 for the N values between 41 and 46 respectively. The net safe bearing capacity value obtained from IS6403 for ϕ=36° is 1300kN/m^2 for FS=3. The soil at the foundation level of certain boreholes is stiff sandy clay with fines around 25%. Though thickness of sandy clay layer is less the bearing capacity value is determined by considering the lowest N value of 41 is 358kN/m^2 for a settlement of 25mm. Thus it is sure that the soils at the foundation levels are having good bearing strength and more over raft foundation of large size will provide higher bearing resistance and the settlement is real concern. The recommended bearing capacity is 250kN/m^2. The bearing capacity is reduced from the minimum value of 358kN/m^2 obtained, in order to account for the undesirable condition like presence of clay pockets. The average load intensity expected at the foundation level for the combination of load may not exceed 220kN/m^2, which is close to the bearing capacity recommended. The shallow foundation like isolated footing is not considered because of heterogeneous nature of soil (week zones like clay patches and clay lumps). However as an academic exercise the capacity was worked for the isolated footing of 2.5mx2.5m for the ϕ'=36°. The net safe bearing capacity obtained is 190kN/m^2, which is less than the expected average pressure of 220kN/m^2 of raft foundation. However the contact pressure expected will be more than 190kN/m^2 if isolated footing is proposed to adopt for each column. If the bearing capacity is limited to 190kN/m^2 then foundations of columns are to be combined. Thus only option to support the buildings of stilt+eight storeyed buildings in the Zone 'M2' of Perumbakkam project is raft foundation.

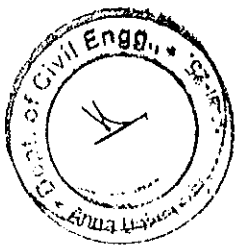
The settlement of raft foundation is also worked out for the soil conditions of individual borehole for the net pressure of 250kN/m^2. The foundation is supported in

silty sand / clayey sand layer which is non-plastic with course fractions around 70% followed by weathered/fractured rock. Therefore elastic settlement of foundation is obtained using DeBeer and Martens (1957) equation. The elastic settlement obtained at various locations is less than 25mm for the contact pressure of 250kN/m^2. Thus the raft foundation is the ideal choice for supporting the foundations of proposed stilt + eight storeyed blocks M7 to M12 at Zone 'M2'.

The one more issue is depth of foundation of each block can be different because of variation in depth of occurrence of bearing stratum within the Zone M2. Further providing uniform depth of foundation for all the six blocks (M7 to M12) will lead to more excavation at locations of certain blocks. The minimum depth of foundation (RL) at various blocks is varying between -1.75m and -2.75m. In this area the water table level at boreholes is found to vary between +0.51m and +0.009m, and is above the recommended level of foundation, hence interference of water table cannot be avoided while executing the earthwork excavation to reach proposed level of foundation. The foundation excavation in presence of water is to be avoided. Adopt suitable dewatering method to lower the level of water table at least to a level of 0.5m below the foundation level.

10. Recommendations

The subsurface exploration conducted at Zone 'M2' confirms presence of good bearing stratum at a depth of 3.2m at Block M7 and at a depth of 4m at block M11.Thus occurrence of good bearing stratum is at shallow depth on the western side of Zone M2 and slopping towards east direction. However the deposit at the depth below 5.5m is certainly weathered rock over entire area of Zone M2. The top layer is soft at most of the locations and at locations wherever clay is medium stiff to stiff possesses volume change characteristics. This layer will exhibit high swelling (DFS>100%). Thus it is recommended to locate the foundation at a minimum depth of 3.2m from the lowest ground level. For the structure of stilt + 8 storeyed building it is recommended to support the structure on a raft foundation. The recommended bearing capacity of soil for the raft foundation of 23m x 46m (approximate size) is 250kN/m^2. Though the soil below the



depth of foundation possesses higher bearing strength, it is advised not to exceed the value of 250kN/m^2 because of non-homogenous nature of the deposit. Recommended level of foundation for the blocks M7 to M12 is as below:

Sl.No:	Block	Reduced level of Foundation,(m)
1	M7	-2.0
2	M8	-2.0
3	M9	-2.0
4	M10	-2.0
5	M11	-2.75
6	M12	-2.6

The level of foundation refers to base of a raft and the raft shall be laid on leveling course followed by sand cushion of adequate thickness each as per the practice in the board.

11. Precautions

1. The top soil to the depth of 3.0m is poor and highly swelling (expansive) hence does not suitable for any construction or filling work.
2. The maximum depth of occurrence of water table in zone M2 is +0.009m (RL) and the soil at this depth is clayey at most of the location hence excavation under this condition without dewatering will lead to collapse of cut and also reduction in strength of soil because of seepage through the bearing stratum.
3. Earth work excavation particularly below the water table to be allowed unless the water level is lowered to minimum depth of 0.5m from the recommended level of foundation. Adopt suitable scientific method for dewatering.
4. The depth of foundation recommended for each block is minimum depth of foundation. There may be chances for variation in foundation depth because of uncertainty in the characteristics of highly weathered residual deposit in the Zone M2 area. Improper dewatering and submergence of weathered soil may lead to significant reduction in strength, which may demand foundation at deeper depth than recommended to realize bearing capacity of 250kN/m^2. Do not reduce the foundation

depth without obtaining proper approval from the consultant in case of good bearing stratum is met at higher level than the recommended level of foundation.

5. The water table in this area is at shallow depth. The seepage of water at the interface of weathered rock and soil cover will be critical hence conduct a pilot study to determine seepage parameters of deposits and to design suitable dewatering system. Technical support required for designing the dewatering system will be provided if required by the client. No case seepage is permitted directly through the foundation soil i.e. seepage of water shall be away from the excavation area (i.e. foundation area) and not towards the excavation area.
6. The quality of ground water is not suitable for any construction work especially for foundation construction. Since the environment of both ground water and soil is aggressive, this will lead to sulphate attack on concrete and corrosion of reinforcement. The concrete and steel need to be protected from the aggressive action. Thus provide minimum cover of 75mm in addition to any other protective measures considered suitable. Obtain opinion from structural engineer for protecting foundation elements and part of columns and beams buried below the ground. Further the cement quality and the content shall satisfy the requirement of Table 4 of IS 456-2000.
7. Since the ground water is not satisfying the requirement, use good water for all concrete related work. Minimum grade of concrete recommended for the foundation work is M25. Follow the conditions relevant to quality of water for concrete work as per IS 456-2000 including minimum cover thickness.
8. For filling works both inside the basement and outside around the building use good earth. The native soil particularly the high plastic clay is not at all suitable for any construction work including basement filling.
9. The basement filling will be more than 3.0m hence conventional flooring for the ground storey may lead to settlement problem on later days. It is suggested to provide RCC floor for ground floor base slab.



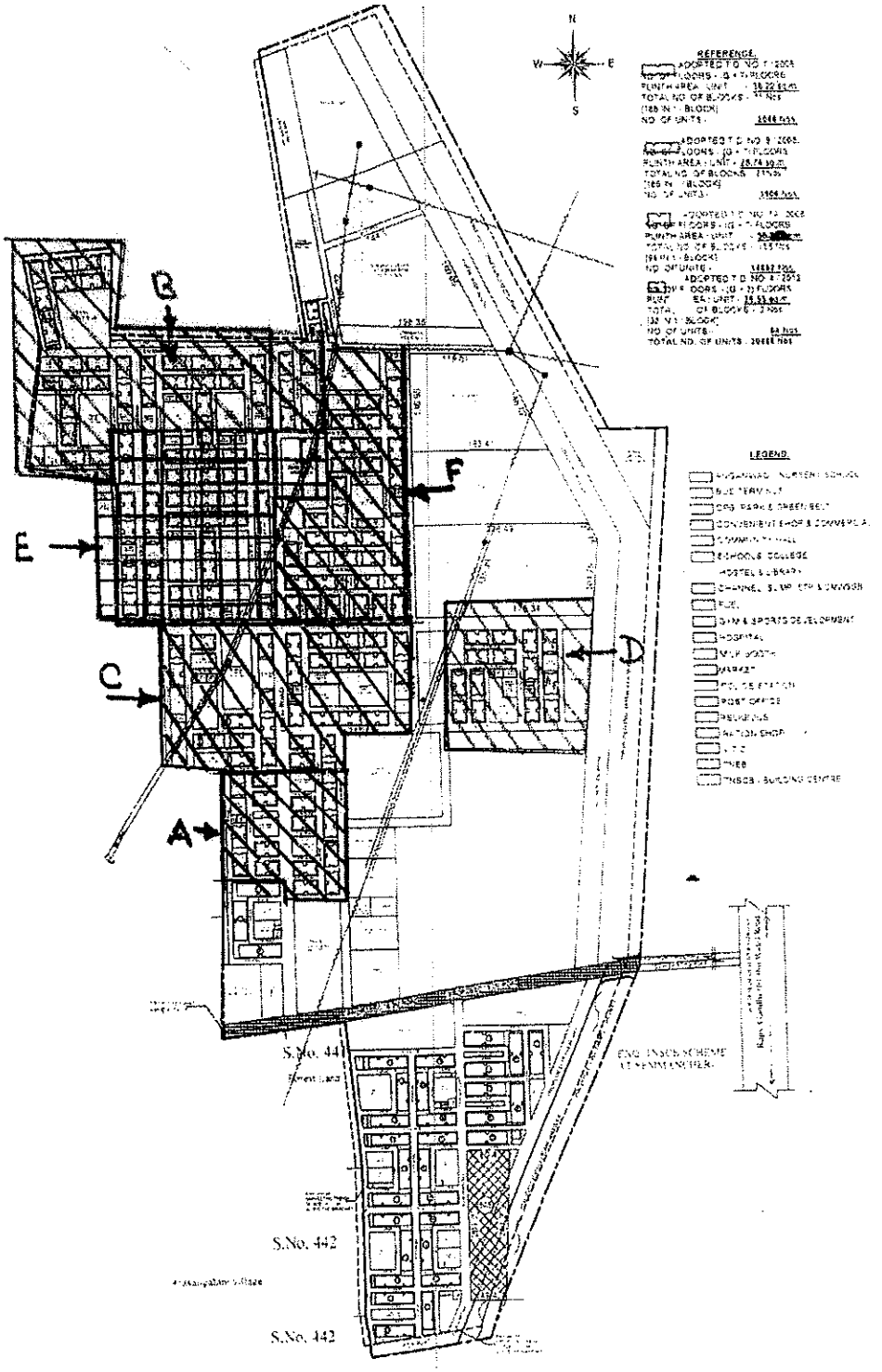
10. In case of any variation observed from the soil profile reported while execution of foundation work, bring it to the notice of consultant immediately for suitable advice. Do not change the recommended level of foundation without the knowledge of foundation consultant.

25/7/2014

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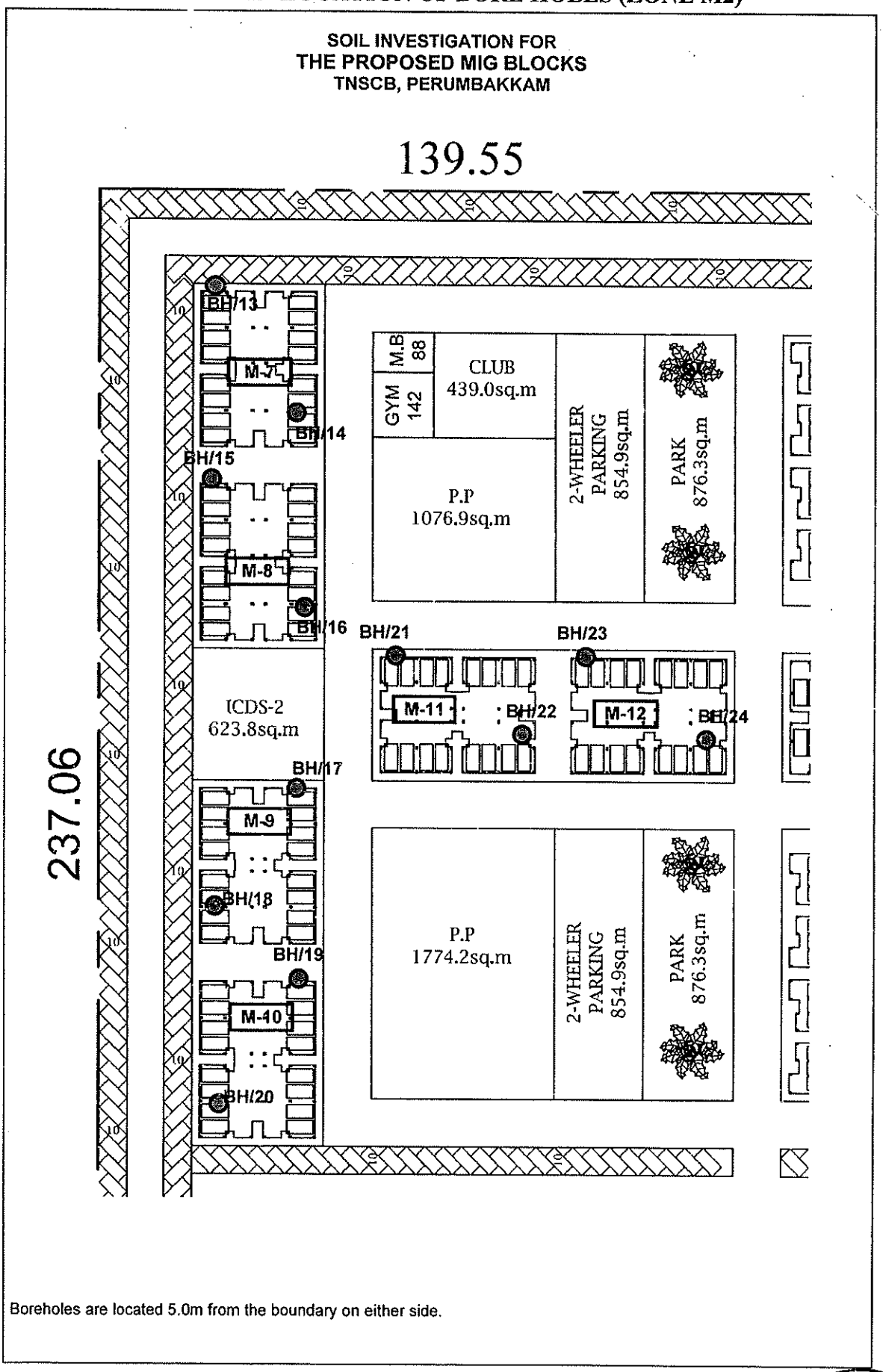
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Figure A1 Perumbakkam Project – Zones of Investigation



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FIGURE 1B LOCATION OF BORE HOLES (ZONE M2)



Boreholes are located 5.0m from the boundary on either side.

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FIGURE 2 SOIL PROFILE AND SPT N VALUES AT BH 13 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/13

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam, M2 Zone
Co-ordinates : Block M7
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 10-Mar-2013
Date of finish : 11-Mar-2013
GWL from GL : 1.40m
Ground level RL : 1.688m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
1.0		Yellowish grey silty clay with few stones		0.50							Medium stiff
1.3				0.75	0.75	2	4	6	11	10	
1.8		Greyish brown sandy silty clay with stones		1.50	1.50	5	8	17	23	25	Stiff
2.0				2.25	2.25	10	15	32		47	Dense
3.0		Greyish brown clayey silty fine to coarse sand with sandy clay lumps		3.00	3.00	38	50/8cm			>100	
3.2				3.75	3.75	50/8cm				>100	Very dense
4.0		Greyish brown dirty fine to coarse sand with weathered stones (weathered disintegrated rock)		4.50	4.50	30/4cm				>100	
5.0					5.50	Rebound				RB	
5.5					TC core drilling						
6.0		Yellowish grey highly weathered fractured rock	5.50-6.30		6.30	Rebound				RB	Very weak
6.3											
7.0		Brownish grey highly / completely weathered severely jointed rock	6.30-7.30		Diamond core drilling NX size, recovery nil						Weak
8.0			7.30-8.30		Diamond core drilling NX size, recovery 13%, RQD nil						
9.0		Br grey highly weathered severely jointed rock									Weak
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.50m to 6.30m DC core drilling from 6.30m to 8.30m									

Borehole terminated at 8.30m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

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FIGURE 3 SOIL PROFILE AND SPT N VALUES AT BH 14 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/14

Project MIG Tenements, TNSCB, Chennai
Site Perumbakkam, M2 Zone
Co-ordinates : Block M7
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 12-Mar-2013
Date of finish : 13-Mar-2013
GWL from GL : 1.40m
Ground level RL : 1.451m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	SPT blow counts					
			UDS	DS	m	15	30	45	60	N**	
1.0		Yellowish grey silty clay with roots in the top 0.40m		0.50							Medium stiff
1.4				0.75	0.75	2	2	3	4	5	
2.0		Yellowish grey silty clay with white stones and gravel		1.50	1.50	4	7	10	13	17	Stiff
2.2											
3.0		Greyish brown clayey silty sand with sandy clay lumps & weathered stones		2.25	2.25	8	12	13	16	25	Medium dense
		Greyish brown dirty fine to coarse sand with weathered stones		3.00	3.00	21	32	50		82	Very dense
4.0				3.75	3.75	32	50/12cm			>100	
5.0		Brownish grey dirty fine to coarse sand with weathered stones		4.50	4.50	50/5cm				>100	Very dense
					5.00	Rebound				RB	
5.7		Greyish brown highly weathered fractured rock	5.00-5.70		TC core drilling 5.70	Rebound					Very weak
6.0		Greyish brown highly weathered severely jointed rock	5.70-6.70		Diamond core drilling NX size, recovery 15% RQD nil						Weak
7.0			6.70-7.70		Diamond core drilling NX size, recovery 8%, RQD nil						
8.0											
8.2		Brownish grey highly weathered closely jointed rock (Granitic gneiss)	7.70-8.70		Diamond core drilling NX size, recovery 14%, RQD nil						Moderate
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.00m to 5.70m DC core drilling from 5.70m to 8.70m									

Borehole terminated at 8.70m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 4 SOIL PROFILE AND SPT N VALUES AT BH 15 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/15

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam, M2 Zone
Co-ordinates : Block M8
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 13-Mar-2013
Date of finish : 14-Mar-2013
GWL from GL : 1.30m.
Ground level RL : 1.339m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.5		Brownish grey silty clay with roots		0.50							Medium stiff
1.0		Yellowish grey silty clay		0.75	0.75	2	3	5	7	8	Medium stiff
1.7				1.50	1.50	6	9	12	17	21	
2.0		Greyish brown clayey silty sand with weathered stones									Med dense
2.3				2.25	2.25	16	34	50		84	
3.0		Yellowish grey dirty fine to coarse sand with sandy clay lumps		3.00	3.00	30/10cm				>100	Very dense
3.2			3.00-3.60m		3.60	Rebound				RB	
4.0		Brownish grey highly weathered fractured rock	3.60-4.60		Diamond core drilling NX size, recovery nil						Weak
5.0			4.60-5.60		Diamond core drilling NX size, recovery nil						
5.6											
6.0		Brownish grey completely weathered severely jointed rock	5.60-6.60		Diamond core drilling NX size, recovery 4%						Weak
6.8											
7.0		Greyish partly weathered jointed rock (granitic gneiss)	6.60-7.60		Diamond core drilling NX size, recovery 13%, RQD nil						Moderate
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 3.00m to 3.60m DC core drilling from 3.60m to 7.60m									

Borehole terminated at 7.60m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 5 SOIL PROFILE AND SPT N VALUES AT BH 16 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/16

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam, M2 Zone
Co-ordinates : Block M8
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 14-Mar-2013
Date of finish : 15-Mar-2013
GWL from GL : 1.10m
Ground level RL : 1.240m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.5		Yellowish grey silty clay (dry)		0.50							
1.0		Yellowish grey and brown silty clay with few stones		0.75	0.75	2	4	6	7	10	Medium stiff to stiff
2.0				1.50	1.50	7	9	10	14	19	
2.1		Yellowish grey clayey silty sand with sandy clay lumps		2.25	2.25	10	14	27	32	41	Dense
3.0				3.00	3.00	28	32	50		82	
3.8		Brownish grey dirty fine to medium sand with sandy clay lumps		3.75	3.75	50/13cm				>100	Very dense
4.0		Greyish dirty fine to coarse sand with weathered stones (wdr)			4.50	Rebound				RB	
4.7											
5.0		Brownish grey highly weathered fractured rock	4.50-5.80		TC core drilling						Very weak
5.8					5.80	Rebound				RB	
6.0		Yellowish grey highly / completely weathered calcareous sandstone	5.80-6.80		Diamond core drilling NX size, recovery 10%, RQD nil						Weak
7.0			6.80-7.80		Diamond core drilling NX size, recovery 13%, RQD nil						
8.0			7.80-8.30		DC Core drilling						
8.1		Brownish grey dirty fine to coarse sand with weathered stones		8.30	8.30	50/13cm				>100	Very dense
9.0			8.30-9.20		TC core drilling						
9.2		Greyish partly weathered and severely jointed rock	9.20-10.20		Diamond core drilling NX size, recovery 16%, RQD nil						Weak
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 4.50m to 5.80m DC core drilling from 5.80m to 8.30m & 9.2m to 10.20m									

Borehole terminated at 10.20m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

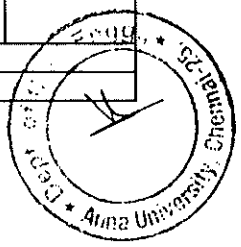


FIGURE 6 SOIL PROFILE AND SPT N VALUES AT BH 17 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/17

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam, M2 Zone
Co-ordinates : Block M9
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 16-Mar-2013
Date of finish : 17-Mar-2013
GWL from GL : 1.40m
Ground level RL : 1.492m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.5		Brownish grey silty clay with sand		0.50							Medium stiff
1.0		Brownish grey soft silty clay		0.75	0.75	1				0	Very soft
1.4											
2.0		Dark grey soft silty clay with gravel and organic material		1.50	1.50	Sunk @ SPT wt				0	Very soft
2.3											
3.0		Greyish clayey silty fine to coarse sand with weathered stones		2.25	2.25	7	15	23	29	38	Dense
3.2				3.00	3.00	9	17	24	33	41	
4.0		Brownish grey clayey silty fine to coarse sand with weathered stones		3.75	3.75	50/09cm				>100	Very dense
4.2					4.00	Rebound				RB	
5.0		Dark greenish grey completely weathered fractured rock	4.00-5.00		TC core drilling 5.00	Rebound				RB	Very weak
6.0			5.00-6.00		TC core drilling 6.00	Rebound				RB	
7.0		Yellowish grey highly weathered severely jointed rock	6.00-7.00		Diamond core drilling NX size recovery nil						Weak
8.0		Brownish and light yellowish fully weathered severely jointed rock	7.00-8.00		Diamond core drilling NX size recovery 9%, RQD nil						Weak
8.3											
9.0		Yellowish grey and grey highly weathered severely jointed rock	8.00-9.00		Diamond core drilling NX size recovery 16%, RQD nil						Weak to moderate
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 4.00m to 6.00m DC core drilling from 6.00m to 9.00m									

Borehole terminated at 9.00m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

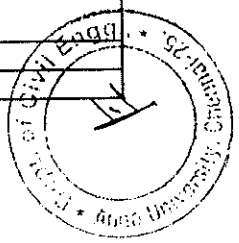


FIGURE 7 SOIL PROFILE AND SPT N VALUES AT BH 18 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/18

Project MIG Tenements, TNSCB, Chennai
Site Perumbakkam, M2 Zone
Co-ordinates : Block M9
Diameter and type of boring : 50mm Rotary boring with drilling mud circulation

Date of start : 18-Mar-2013
Date of finish : 19-Mar-2013
GWL from GL : 1.40m
Ground level RL : 1.409m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.5		Yellowish grey silty clay with black patches		0.50							Medium stiff
1.0		Brownish grey silty clay with reddish brown patches		0.75	0.75	1	1	1	2	2	Soft
1.4 / 2.0		Yellowish grey and brownish silty clay		1.50	1.50	2	3	5	11	8	Medium stiff
2.9 / 3.0		Brownish clayey silty fine to medium sand / sandy silty clay		2.25	2.25	6	10	14	18	24	Med dense
3.7		Greyish brown dirty fine to coarse sand with weathered stones		3.00	3.00	22	31	43		74	Very dense
4.0		Yell grey clayey silty fine to coarse sand with weathered stones (wdr)		3.75	3.75	36	50/8cm			>100	Very dense
4.5					4.50	Rebound				RB	
5.0		Yellowish grey highly / completely weathered fractured rock	4.50-5.50		TC core drilling 5.50	Rebound				RB	Very weak
5.5 / 6.0		Greyish brown & grey completely weathered severely jointed rock	5.50-6.50		Diamond core drilling NX size recovery 6%						Weak
6.5 / 7.0		Brownish and grey highly weathered severely jointed rock	6.50-7.50		Diamond core drilling NX size recovery 15%, RQD nil						Weak
8.0			7.50-8.50		Diamond core drilling NX size recovery 22%, RQD nil						
9.0 / 10.0 / 11.0 / 12.0 / 13.0 / 14.0 / 15.0 / 16.0 / 17.0 / 18.0 / 19.0 / 20.0		TC core drilling from4.50m to 5.50m DC core drilling from 5.50m to 8.50m									

Borehole terminated at 8.50m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 8 SOIL PROFILE AND SPT N VALUES AT BH 19 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/19

Project MIG Tenements, TNSCB, Chennai
Site Perumbakkam, M2 Zone
Co-ordinates : Block M10
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 19-Mar-2013
Date of finish : 20-Mar-2013
GWL from GL : 1.30m
Ground level RL : 1.409m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	SPT blow counts 15	30	45	60	N**	
0.6		Br grey silty clay with brown & black patches		0.50							Medium stiff
1.0		Yellowish grey soft silty clay with reddish brown patches		0.75	0.75	0	1	1	1	2	Soft
1.4				1.50	1.50	@SPT wt			1	0	Very soft
2.0		Greyish soft silty clay with reddish brown patches		2.25	2.25	2	12	19	27	31	
2.4				3.00	3.00	16	20	24	31	44	Dense
3.0		Brownish grey dirty fine to coarse sand weathered stones		3.75	3.75	16	50			>100	
4.0					4.50	Rebound				RB	
5.0		Brownish grey completely weathered / highly weathered fractured rock	4.50-5.50		TC core drilling 5.50	Rebound				RB	Very weak
5.5											
6.0		Brownish highly weathered severely jointed rock (siltstone)	5.50-6.50		Diamond core drilling NX size, recovery 19%, RQD nil						Weak
6.7											
7.0		Light brownish and light grey widely jointed hard rock (siltstone)	6.50-7.50		Diamond core drilling NX size, recovery 31%, RQD 28%						Strong
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 4.50m to 5.50m DC core drilling from 5.50m to 7.50m									

Borehole terminated at 7.50m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 9 SOIL PROFILE AND SPT N VALUES AT BH 20 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/20

Project MIG Tenements, TNSCB, Chennai
Site Perumbakkam, M2 Zone
Co-ordinates : Block M10
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 20-Mar-2013
Date of finish : 21-Mar-2013
GWL from GL : 1.10m
Ground level RL : 1.250m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
0.6		Yellowish grey silty clay		0.50							Soft
1.0		Light grey very soft silty clay with reddish brown patches		0.75	0.75	Sunk @ SPT wt				0	Very soft
1.4				1.50	1.50	3	4	6	8	10	Medium stiff
2.0		Brownish grey silty clay with gravel and sand		2.25	2.25	7	9	15	18	24	
2.6				3.00	3.00	29	50/14cm			>100	Very dense
3.0		Yellowish grey clayey silty fine to coarse sand with weathered stones			3.75	Rebound				RB	
3.4											
4.0		Yellowish grey completely / highly weathered fractured rock	3.75-4.80		TC core drilling						Very weak
4.8					4.80	Rebound				RB	
5.0		Light brownish grey weathered closely jointed rock	4.80-5.80		Diamond core drilling NX size, recovery 12%, RQD nil						Weak to moderate
6.0											
6.2		Light brown and grey widely jointed hard rock (siltstone)	5.80-6.80		Diamond core drilling NX size, recovery 25%, RQD 25%						Hard
7.0											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 3.75m to 4.80m DC core drilling from 4.80m to 6.80m									

Borehole terminated at 6.80m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

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FIGURE 10 SOIL PROFILE AND SPT N VALUES AT BH 21 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/21

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam, M2 Zone
Co-ordinates : Block M11
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 22-Mar-2013
Date of finish : 23-Mar-2013
GWL from GL : 1.20m
Ground level RL : 1.354m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	SPT blow counts					
			UDS	DS	m	15	30	45	60	N**	
0.6		Yellowish grey medium stiff silty clay		0.50							Medium
1.0		Yellowish grey soft silty clay with yellow patches		0.75	0.75	1	1	1	2	2	Soft
1.4											
1.9		Lt grey soft silty clay with reddish brown patches		1.50	1.50	1	3	4	10	7	Soft
2.0		Yell brown and grey sandy silty clay with gravel									Medium stiff
2.3				2.25	2.25	14	20	24	30	44	
3.0		Yell grey clayey silty sand with sandy clay lumps and weathered stones		3.00	3.00	15	18	31		49	Dense
4.0				3.75	3.75	23	50/12cm			>100	
4.5		Yellowish grey dirty fine to coarse sand			4.50	Rebound				RB	Very dense
5.0		Yellowish grey highly weathered fractured rock	4.50-5.50		TC core drilling						Very weak
5.5					5.50	Rebound				RB	
6.0		Greyish weathered severely jointed rock	5.50-6.50		Diamond core drilling NX size, recovery 17%, RQD nil						Weak
7.0			6.50-7.50		Diamond core drilling NX size, recovery 19%, RQD nil						
8.0			7.50-8.50		Diamond core drilling NX size, recovery 18%, RQD nil						
8.1		Brownish & grey weathered closely jointed rock									Moderate
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 4.50m to 5.50m DC core drilling from 5.50m to 8.50m									

Borehole terminated at 8.50m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

FIGURE 11 SOIL PROFILE AND SPT N VALUES AT BH 22 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/22

Project : MIG Tenements, TNSCB, Chennai
Site : Perumbakkam, M2 Zone
Co-ordinates : Block M11
Diameter and type of boring : 150.mm Rotary boring with drilling mud circulation

Date of start : 23-Mar-2013
Date of finish : 23-Mar-2013
GWL from GL : 1.00m
Ground level RL : 1.267m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT blow counts 15	30	45	60	N**	RD / Consistency
1.0		Yellowish grey silty clay		0.50							Soft to medium stiff
1.3				0.75	0.75	1	1	2	2	3	
2.0		Dark grey soft clay with reddish brown patches		1.50	1.50	Sunk @ SPT wt				0	Very soft
2.6											
3.0		Black organic sandy clay		2.75	2.75	@SPT wt			1	0	Very soft
3.4											
4.0		Dark greenish grey dirty fine to medium sand		3.50	3.50	3	8	9	23	17	Loose
4.8		Dark brownish grey dirty fine to coarse sand with weathered stones		4.50	4.50	35	50/8cm			>100	Very dense
5.0		Brownish grey dirty fine to coarse sand with weathered stones			5.50	Rebound				RB	Very dense
5.6											
6.0		Brownish grey highly weathered fractured rock	5.50-6.70		TC core drilling						Very weak
6.7					6.70	Rebound				RB	
7.0		Brownish and grey highly weathered severely jointed rock	6.70-7.70		Diamond core drilling NX size, recovery nil						Weak
8.0			7.70-8.70		Diamond core drilling NX size, recovery 10%, RQD nil						
9.0			8.70-9.70		Diamond core drilling NX size, recovery 19%, RQD nil						
9.1		Br and grey weathered closely jointed rock									Moderate
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.50m to 6.70m DC core drilling from 6.70m to 9.70m									

Borehole terminated at 9.70m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

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FIGURE 12 SOIL PROFILE AND SPT N VALUES AT BH 23 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/23

Project MIG Tenements, TNSCB, Chennai
Site Perumbakkam, M2 Zone
Co-ordinates : Block M12
Diameter and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 25-Mar-2013
Date of finish : 25-Mar-2013
GWL from GL : 1.00m
Ground level RL : 1.200m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	SPT blow counts					
			UDS	DS	m	15	30	45	60	N**	
0.6		Yellowish grey silty clay		0.50							Medium stiff
1.0		Light brownish grey soft silty clay with yellow patches		0.75	0.75	@SPT wt			1	0	Very soft
2.0				1.50	1.50	Sunk @ SPT wt				0	
2.2		Dark grey very soft silty clay with medium sand patches and decayed wood		2.25	2.25	Sunk @ SPT wt				0	Very soft
3.0				3.00	3.00	0	1	2	25	3	
3.5											
4.0		Dark yellowish grey dirty fine to coarse sand weathered stones		3.75	3.75	50/15cm				>100	Very dense
4.6				4.50	4.50	30/6cm				>100	
5.0		Dark yellowish grey completely weathered fractured rock			5.50	Rebound				RB	Very weak
5.5											
6.0		Yellowish grey highly weathered fractured rock	5.50-6.30		TC core drilling						Very weak
6.3					6.30	Rebound				RB	
7.0		Brownish and grey weathered severely jointed rock	6.30-7.30		Diamond core drilling NX size, recovery 8%, RQD nil						Weak
8.0			7.30-8.30		Diamond core drilling NX size, recovery 12%, RQD nil						
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.50m to 6.30m DC core drilling from 6.30m to 8.30m									

Borehole terminated at 8.30m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}

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FIGURE 13 SOIL PROFILE AND SPT N VALUES AT BH 24 - M2

PROJECT NO:	SF/KI-48/Zone M2/PMPKM
BORE HOLE NO:	BH/24

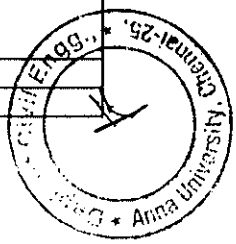
Project MIG Tenements, TNSCB, Chennai
Site Perumbakkam, M2 Zone
Co-ordinates ; Block M12
Diameter and type of boring ; 150mm Rotary boring with drilling mud circulation

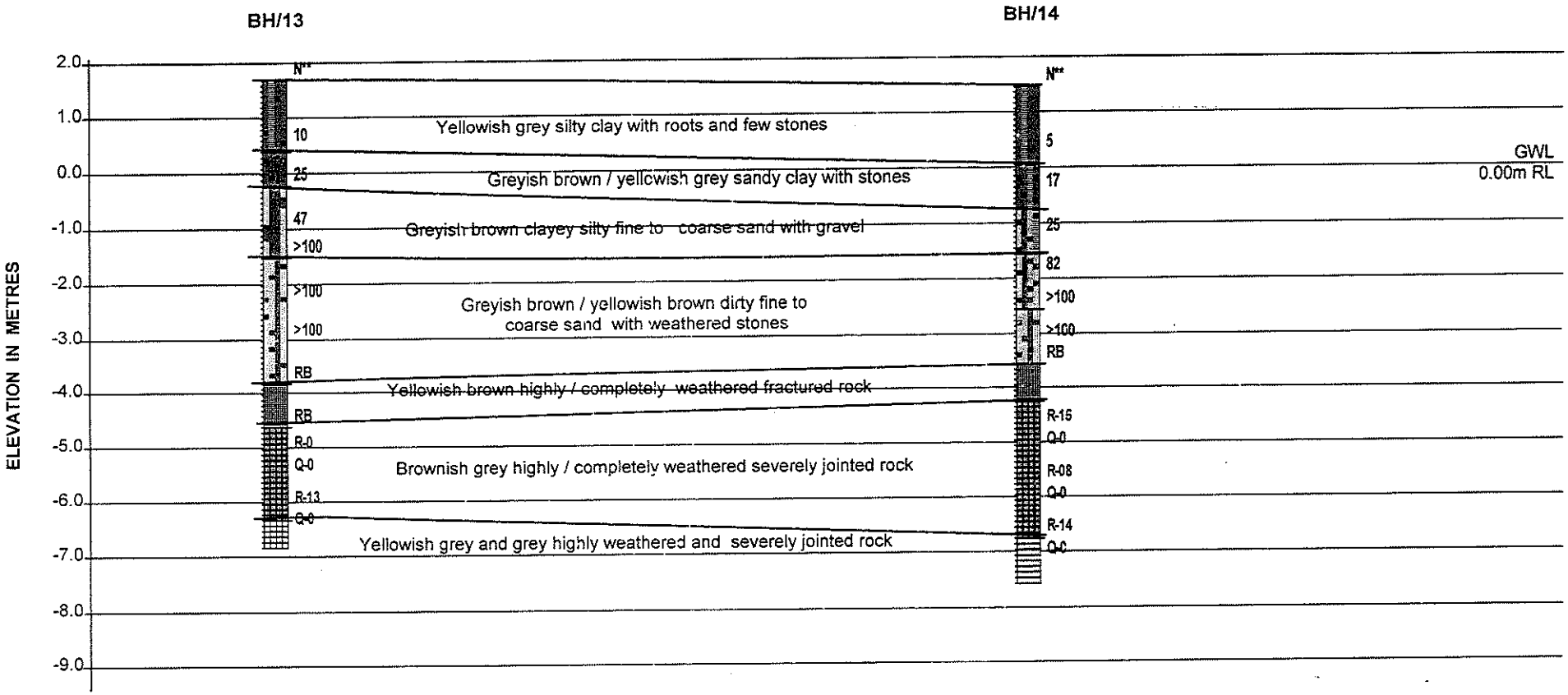
Date of start : 26-Mar-2013
Date of finish : 27-Mar-2013
GWL from GL : 1.00m
Ground level RL : 1.295m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	SPT blow counts 15	30	45	60	N**	
0.5		Yellowish grey silty clay	1.50	0.50							Soft
1.0		Light brownish grey soft silty clay with few stones		0.75	0.75	Sunk @ SPT wt				0	Very soft
1.8 2.0											
2.4		Light grey soft silty clay		2.00	2.00	@SPTwt	20	33		20	Very soft
2.6 3.0		Yell grey dirty fine to coarse sand with w. stones		2.75	2.75	40/4cm				>100	Very dense
3.4		Yellowish grey highly weathered fractured rock	2.75-3.30		3.30	Rebound				RB	Very weak
4.0		Light grey and light brown weathered severely jointed rock	3.30-4.30		Diamond core drilling NX size, recovery 19%, RQD nil						Weak
5.0			4.30-5.30		Diamond core drilling NX size, recovery 24%, RQD nil						
6.0											
7.0											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											
16.0											
17.0											
18.0											
19.0											
20.0		TC core drilling from 5.00m to 6.30m DC core drilling from 6.30m to 8.30m									

Borehole terminated at

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{70}





NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

FIGURE 14

SUB-SOIL PROFILE BH/13 – BH/14 – BLOCK M-7
TNSCB TENEMENTS AT PERUMBAKKAM

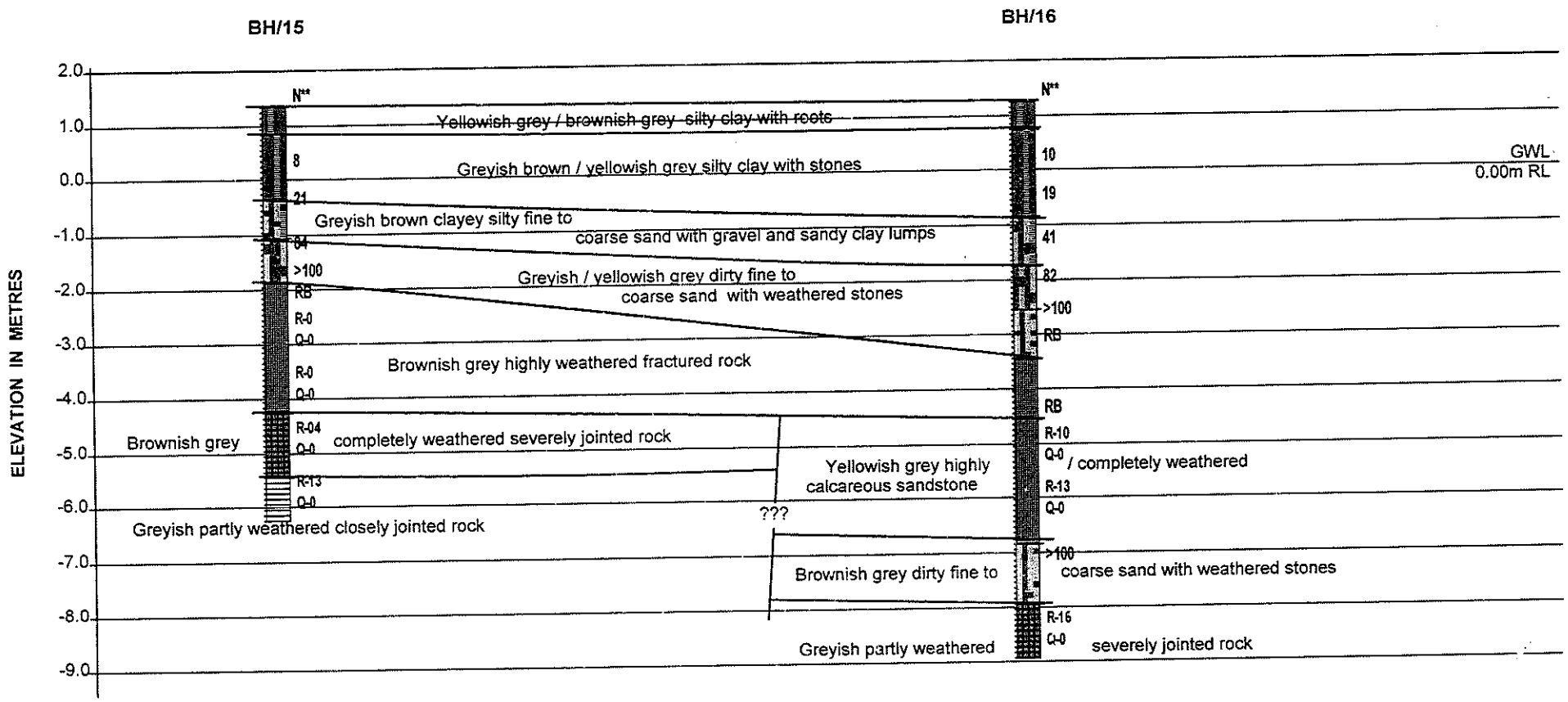
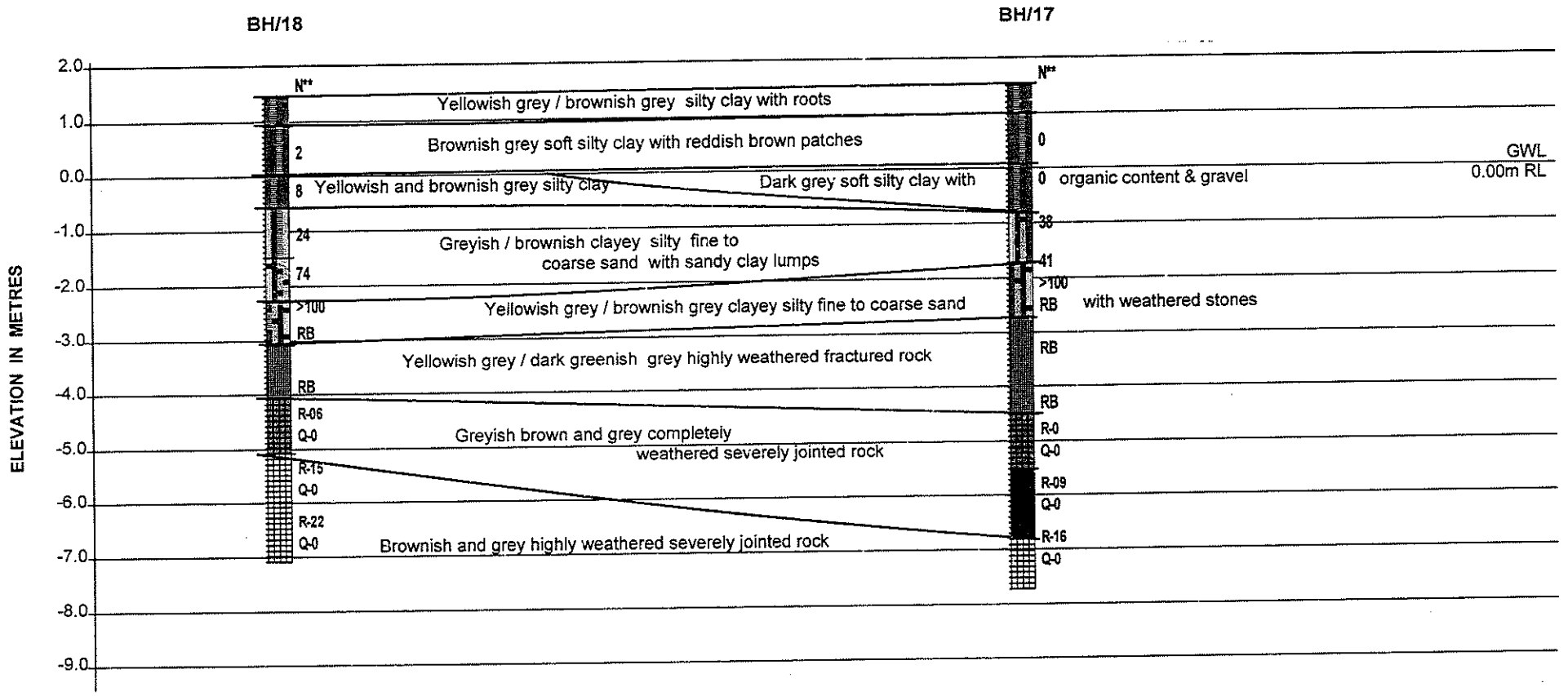


FIGURE 15

SUB-SOIL PROFILE BH/15 – BH/16 – BLOCK M-8
TNSCB TENEMENTS AT PERUMBAKKAM

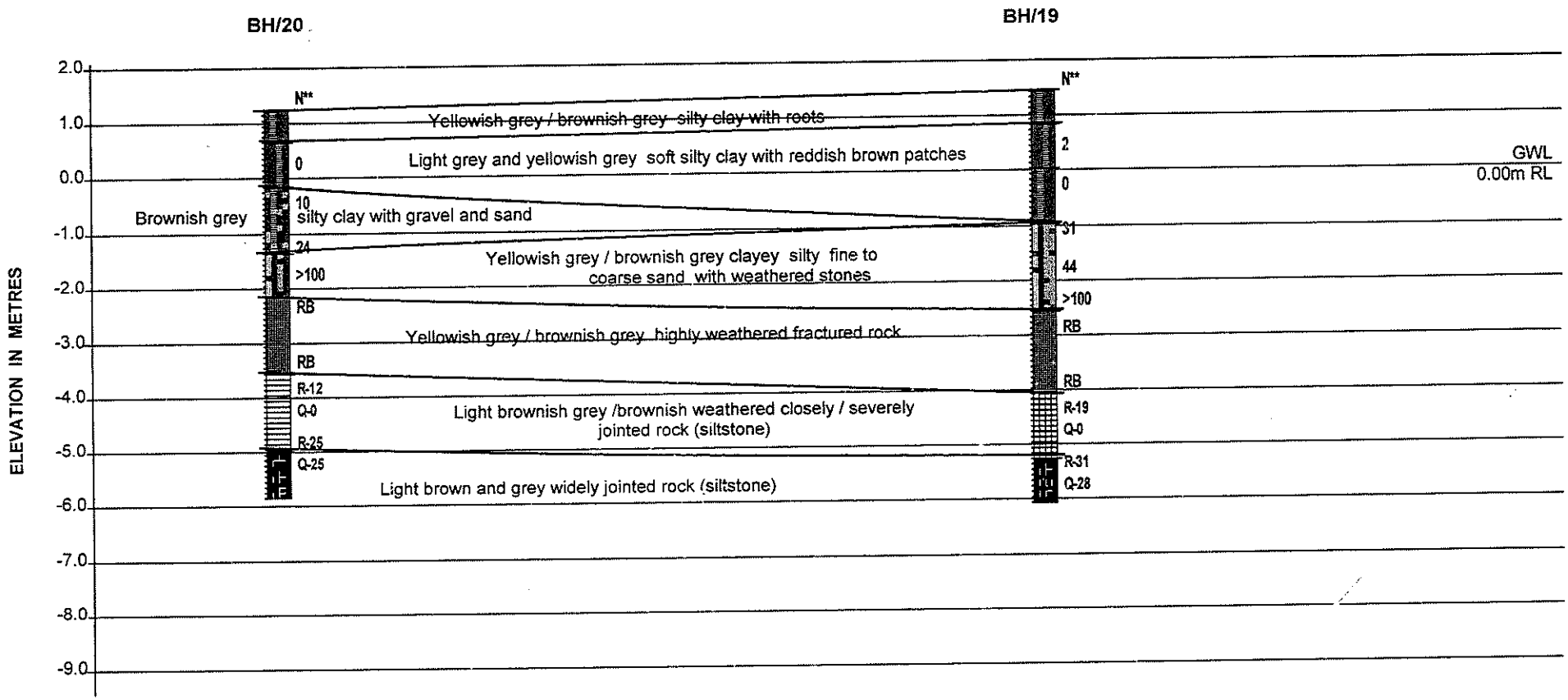
NOTES:
1. The ground elevations with respect to the site reference datum.
2. Ground water table is from the boreholes



NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

FIGURE 16

SUB-SOIL PROFILE BH/18 – BH/17 – BLOCK M-9
TNSCB TENEMENTS AT PERUMBAKKAM



NOTES:
1. The ground elevations with respect to the site reference datum.
2. Ground water table is from the boreholes

FIGURE 17

SUB-SOIL PROFILE BH/20 – BH/19 – BLOCK M-10
TNSCB TENEMENTS AT PERUMBAKKAM

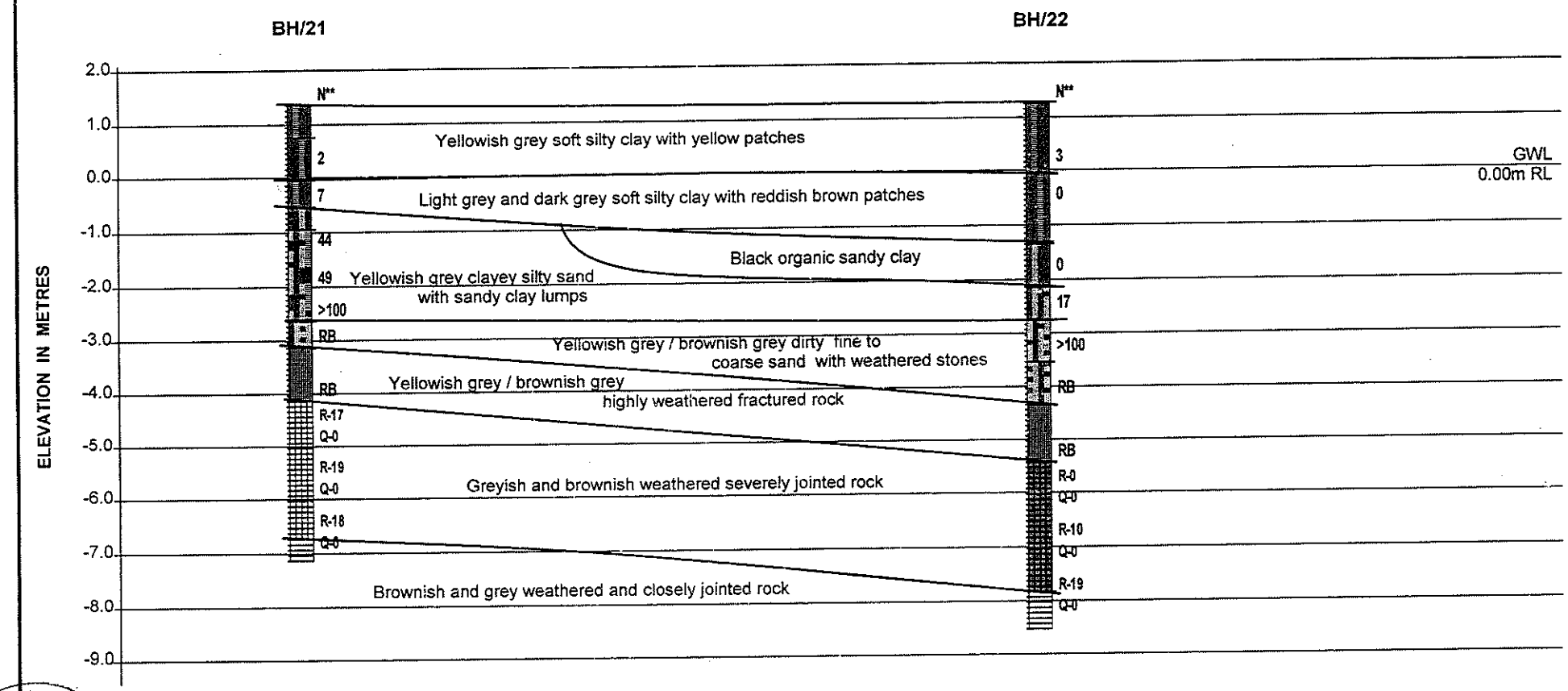


FIGURE 18

SUB-SOIL PROFILE BH/21 – BH/22 – BLOCK M-11
TNSCB TENEMENTS AT PERUMBAKKAM

NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

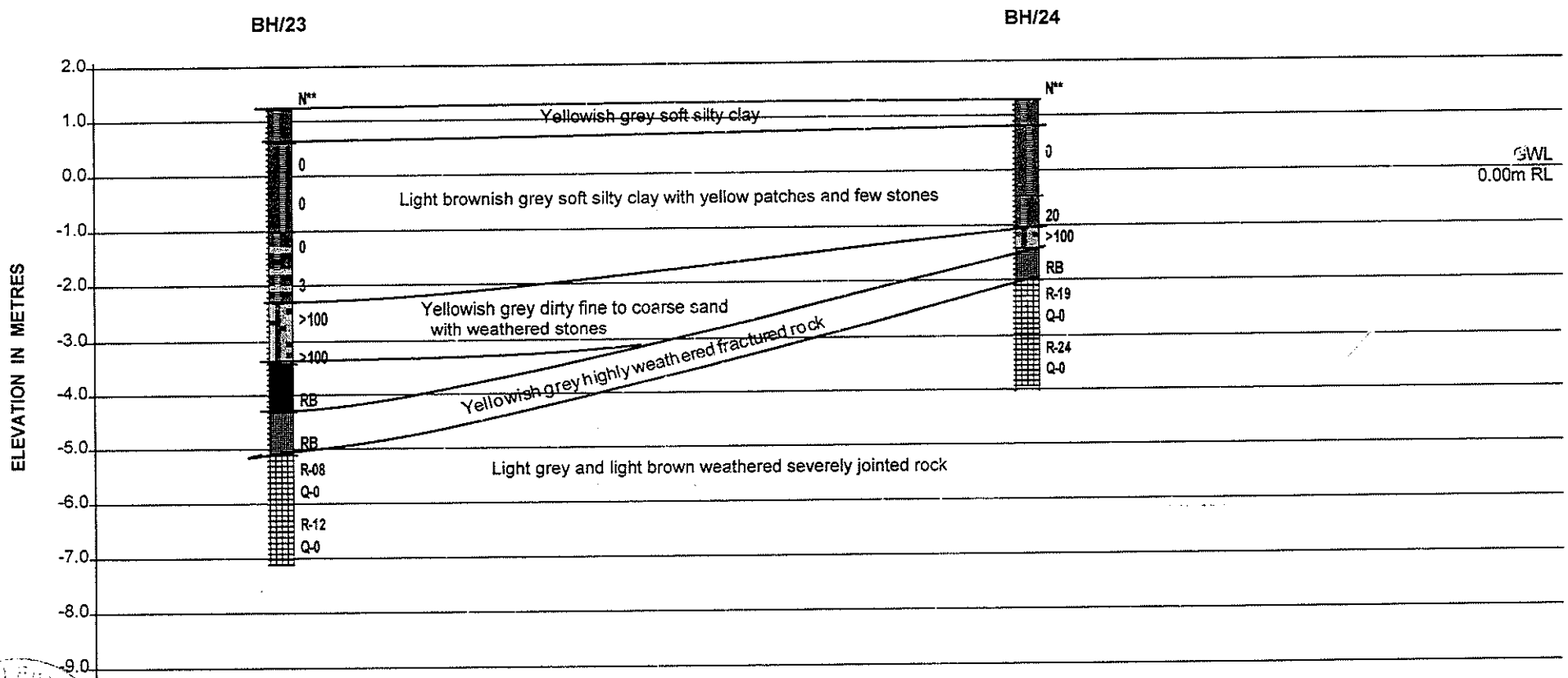


FIGURE 19

NOTES:
The ground elevations with respect to the site reference datum.
Ground water table is from the boreholes

SUB-SOIL PROFILE BH/23 – BH/24 – BLOCK M-12
TNSCB TENEMENTS AT PERUMBAKKAM

TABLE 1 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 13 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH13**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH13															
GL-0.50	DS	Yellowish grey silty clay with few stones			22.1					45.4							
0.75	SPT	Yellowish grey silty clay with gravel and stones	10	CH	33.9	83.3	24.3	59.0	0.163	81.8							
1.50	SPT	TOP: greyish brown sandy silty clay with stones	25	SC/Cl	23.8	65.6	22.6	43.0	0.028	100.0							
		BOT: Greyish brown clayey silty sand with coarse particles			13.2												
2.25	SPT	Greyish brown clayey silty fine to coarse sand with sandy clay lumps	47	SC/SM	19.1							2.7	15.1	36.3	26.9	19.0	
3.00	SPT	Greyish brown dirty fine to coarse sand with weathered stones	>100	SC/SM	23.9							2.0	16.6	36.3	24.7	20.4	
3.75	SPT	Greyish brown dirty fine to coarse sand	>100		17.1												
4.50	SPT	Greyish brown dirty fine to coarse sand with weathered stones (wdr)	>100		15.4												
7.30-8.30		Brownish grey highly weathered severely jointed rock															

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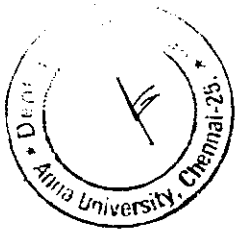


TABLE 2 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 14 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH14**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH14															
GL-0.50	DS	Yellowish grey silty clay with roots		CH	29.4	82.8	21.5	61.3	0.129	191.6							
0.75	SPT	Yellowish grey silty clay	5	CH	32.9	85.3	24.3	61.0	0.141	66.6							
1.50	SPT	Yellowish grey silty clay with white stones and gravel	17	CH	35.7	85.3	24.4	60.9	0.186	141.6							
2.25	SPT	Greyish brown clayey silty sand with sandy clay lumps & weathered stones	25	SC/SM	20.3							2.0	9.5	26.7	31.6	30.2	
3.00	SPT	Greyish brown dirty fine to coarse sand with weathered stones	82		13.6												
3.75	SPT	Greyish brown dirty fine to coarse sand with weathered stones	>100	SM	16.4							9.5	17.0	33.0	24.7	15.8	
4.50	SPT	Brownish grey dirty fine to coarse sand with weathered stones	>100		14.9												
5.70-6.70		Greyish brown highly weathered severely jointed rock															
6.70-7.70		Greyish brown highly weathered severely jointed rock															
7.70-8.70		Brownish grey highly weathered closely jointed rock (Granitic gneiss)															

576

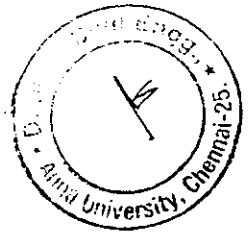


TABLE 3 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 15 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH15**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH15															
GL-050	DS	Brownish grey silty clay with roots		CH	22.3	62.1	19.6	42.5	0.064	65.2							
0.75	SPT	Yellowish grey silty clay	8	CH	30.4	87.7	24.8	62.9	0.089	73.9							
1.50	SPT	TOP: Yellowish grey silty clay	21	CH	28.1	76.4	22.8	53.6	0.099	86.9							
		BOT: Greyish brown clayey silty sand with weathered stones			17.5												
2.25	SPT	Yellowish grey dirty fine to coarse sand with sandy clay lumps	84	SC/SM	16.1							2.4	11.8	44.0	26.3	15.5	
3.00	SPT	Greyish brown dirty fine to coarse sand with weathered stones	>100	SM	14.7							23.4	21.6	26.1	15.9	13.0	
5.60-6.60		Brownish grey completely weathered severely jointed rock															
6.60-7.60		Greyish partly weathered jointed rock (granitic gneiss)															

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TABLE 4 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 16 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH16**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH16															
GL-0.50	DS	Yellowish grey silty clay (dry)			15.0												
0.75	SPT	Yellowish grey silty clay with brown patches	10	CH	30.6	84.2	21.5	62.7	0.145	86.9							
1.50	SPT	Yellowish grey and brown silty clay with few stones	19	CH	33.9	88.1	23.9	64.2	0.156	138.4							
2.25	SPT	Yellowish grey clayey silty sand with sandy clay lumps	41	SC/SM	19.8								3.9	44.4	29.2	22.5	
3.00	SPT	Brownish grey dirty fine to medium sand with sandy clay lumps	82		12.4												
3.75	SPT	Greyish dirty fine to coarse sand with weathered stones (wdr)	>100	SW/SP	11.3							1.5	21.6	50.5	18.1	8.3	
5.80-6.80		Yellowish grey highly / completely weathered calcareous sandstone															
6.80-7.80		Brownish grey completely weathered granitic gneiss / sandstone															
8.30	SPT	Brownish grey dirty fine to coarse sand with weathered stones			13.1												
9.20-10.20		Greyish partly weathered and severely jointed rock															

578

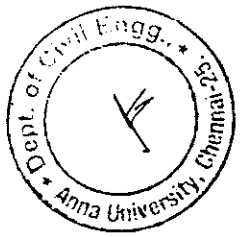


TABLE 5 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 17 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH17**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m tc 1 40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH17															
GL-05	DS	Brownish grey silty clay with sand		SC-CH	17.5	58.4	19.5	38.9	<0.00	70.0							
0.75	SPT	Brownish grey soft silty clay	0	CH	70.0	95.6	26.8	68.8	0.628	83.0							
1.50	SPT	Dark grey soft silty clay with gravel and organic material	0	CH	54.8	77.3	25.8	51.5	0.563	55.0							
2.25	SPT	Greyish clayey silty fine to coarse sand with weathered stones	38	SC/SM	16.0							1.6	15.8	29.2	27.7	25.7	
3.00	SPT	Brownish grey clayey silty fine to coarse sand with weathered stones	41	SC/SM	15.8							5.1	19.1	29.8	24.6	21.4	
3.75	SPT	Brownish grey clayey silty fine to coarse sand	>100		18.5												
7.0-8.0		Brownish and light yellowish fully weathered severely jointed rock															
8.0-9.0		Yellowish grey and grey highly weathered severely jointed rock															

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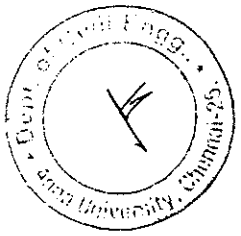


TABLE 6 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 18 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH18**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH18															
GL-0.50	DS	Yellowish grey silty clay with black patches		CH	19.9	57.4	17.5	39.9	0.060	60.0							
0.75	SPT	Brownish grey silty clay with reddish brown patches	2	CH	38.1	74.1	21.6	52.5	0.314	108.0							
1.50	SPT	TOP: Yellowish grey and brownish silty clay	8	CH	29.5	71.3	21.4	49.9	0.162	54.5							
		BOT: Brownish clayey silty fine to medium sand			21.3												
2.25	SPT	Brownish clayey silty fine to medium sand / sandy silty clay	24	SC	18.9							1.8	6.1	22.3	36.5	33.3	
3.00	SPT	Greyish brown dirty fine to coarse sand with weathered stones	74	SM	13.7							9.7	17.5	31.2	27.1	14.5	
3.75	SPT	Yell grey clayey silty fine to coarse sand with weathered stones (wdr)	>100	SP/SM	13.7							28.7	24.6	21.0	13.1	12.6	
5.50-6.50		Greyish brown & grey completely weathered severely jointed rock															
6.50-7.50		Brownish and grey highly weathered severely jointed rock															
7.50-8.50		Brownish and grey highly weathered severely jointed rock															

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TABLE 7 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 19 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH19**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH19															
GL-0.50	DS	Brownish grey silty clay with brown and black patches		CH	29.7	65.4	19.9	45.5	0.215	70.0							
0.75	SPT	Yellowish grey soft silty clay with reddish brown patches	2	CH	37.1	61.7	17.0	44.7	0.450	115.0							
1.50	SPT	Greyish soft silty clay with reddish brown patches	0	CI	34.8	41.5	13.4	28.1	0.762	23.8							
2.25	SPT	TOP: Greyish sandy clay with gravel / clayey sand with gravel	31		19.0												
		BOT: Brownish grey dirty fine to coarse sand		SP/SM	15.6							7.3	22.2	37.4	19.1	14.0	
3.00	SPT	Brownish grey dirty fine to coarse sand weathered stones	44		16.7												
3.75	SPT	Brownish grey dirty fine to coarse sand with weathered stones	>100	SP/SM	13.9							7.9	23.8	35.4	17.2	15.7	
5.50-6.50		Brownish highly weathered severely jointed rock (siltstone)															
6.50-7.50		Light brownish and light grey widely jointed hard rock (siltstone)															

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TABLE 8 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 20 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH20**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH20															
GL-0.50	DS	Yellowish grey silty clay		CH	28.9	61.1	18.2	42.9	0.249	70.0							
0.75	SPT	Light grey very soft silty clay with reddish brown patches	0	CH	38.5	65.8	17.8	48.0	0.431	27.0							
1.50	SPT	Brownish grey silty clay with gravel and sand	10	CH	30.4	71.8	22.8	49.0	0.155	180.0							
2.25	SPT	Yell grey clayey silty fine to med sand with stones & sandy clay lumps	24	SC-SM	15.5							5.5	7.7	25.3	36.8	24.7	
3.00	SPT	Yellowish grey clayey silty fine to coarse sand with weathered stones		SC/SM	12.7							17.7	16.6	26.6	22.1	17.0	
4.80-5.80		Light brownish grey weathered closely jointed rock															
5.80-6.80		Light brown and grey widely jointed hard rock (siltstone)															

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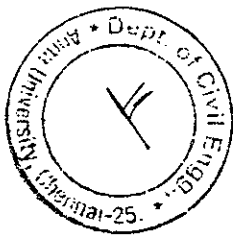


TABLE 9 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 21 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH21**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH21															
GL-0.50	DS	Yellowish grey medium stiff silty clay		CH	22.2	64.4	18.4	46.0	0.083	80.0							
0.75	SPT	Yellowish grey soft silty clay with yellow patches	2	CH	38.2	78.0	21.2	56.8	0.299	175.0							
1.50	SPT	TOP: Light grey soft silty clay with reddish brown patches	7		60.6												
		BOT: Yellowish brown and grey sandy silty clay with gravel		SC/CI	19.5	47.6	16.4	31.2	0.099	68.4							
2.25	SPT	Yell grey clayey silty sand with sandy clay lumps and weathered stones	44	SC/SM	12.1							14.2	20.9	25.4	20.1	19.4	
3.00	SPT	Yell grey clayey silty sand with sandy clay lumps and weathered stones	49	SC/SM	15.5							14.5	21.2	22.7	18.4	23.2	
3.75	SPT	Yellowish grey clayey silty sand with weathered stones	>100		11.3												
5.50-6.50		Greyish weathered severely jointed rock															
6.50-7.50		Greyish weathered severely jointed rock															
7.50-8.50		Brownish and grey weathered closely jointed rock															

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TABLE 10 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 22 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH22**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH22															
GL-0.50	DS	Yellowish grey silty clay		CH	20.4	66.8	20.8	46.0	<0.00	80.0							
0.75	SPT	Yellowish grey silty clay	3	CH	34.2	75.3	21.2	54.1	0.240	90.0							
1.50	SPT	Dark grey soft clay with reddish brown patches	0	CH	68.5	104.7	30.9	73.8	0.509	66.6							
2.75	SPT	Black organic sandy clay	0		42.6												
3.50	SPT	Dark greenish grey dirty fine to medium sand	17	SC/SM	17.8							3.9	13.8	38.4	23.8	20.1	
4.50	SPT	Dark brownish grey dirty fine to coarse sand with weathered stones	>100	SW/SP	14.6							21.2	25.5	32.2	11.6	9.5	
7.70-8.70		Brownish and grey highly weathered severely jointed rock															
8.70-9.70		Brownish and grey weathered closely jointed rock															

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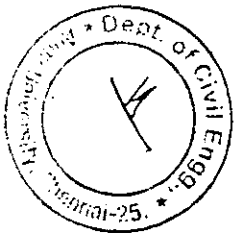


TABLE 11 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 23 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH23**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH23															
GL-0.50	DS	Yellowish grey silty clay		CH	26.7	64.2	20.8	43.4	0.136	90.0							
0.75	SPT	Light brownish grey soft silty clay with yellow patches	0	CH	54.6	93.2	24.9	68.3	0.435	53.8							
1.50	SPT	Light brownish grey very soft clay with yellow patches	0	CH	94.0	100.6	26.8	73.8	0.911								
2.25	SPT	Dark grey very soft silty clay with medium sand patches	0	CH	55.1	58.9	15.7	43.2	0.912	70.0							
3.00	SPT	TOP: Dark grey sandy clay with coarse particles	3	SC	24.0							9.6	13.2	29.6	25.1	22.5	
		MID: Decayed wood			288.9												
		BOT: Dark greenish grey dirty fine to coarse sand weathered stones		SM	12.3							10.6	15.5	27.1	30.1	16.7	
3.75	SPT	Dark yellowish grey dirty fine to coarse sand weathered stones	>100	SM/SP	11.7							13.5	15.3	29.9	27.4	13.9	
4.50	SPT	Dark yellowish grey dirty fine to medium sand with weathered stones	>100		13.4												
6.30-7.30		Brownish and grey weathered severely jointed rock															
7.30-8.30		Brownish and grey weathered severely jointed rock															

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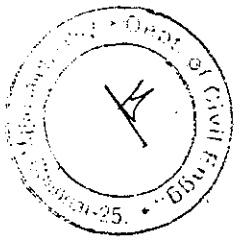


TABLE 12 LABORATORY TEST RESULTS OF SOIL SAMPLES OF BH 24 - M2

Project: **MIG Tenements, TNSCB Perumbakkam**

Borehole Nos: **BH24**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

Ground Water Table: 1.00m to 1.40m, March- April 2013

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	FSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH24															
GL-0.50	DS	Yellowish grey silty clay		CH	22.3	66.3	20.2	46.1	0.046	100.0							
0.75	SPT	Light brownish grey soft silty clay with few stones	0	CH	62.9	93.2	26.8	66.4	0.544	46.0							
1.50	UDS	TOP: Light brownish grey soft silty clay with few stones			55.6												
		BOT: Light grey soft silty clay		CH	85.7	83.3	23.2	60.1	1.070	70.0							
2.00	SPT	TOP: Greyish soft silty clay	20		90.6												
		BOT: Yellowish grey dirty fine to coarse sand with weathered stones		SC/SM	16.6							3.0	12.7	26.2	36.2	21.9	
2.75	SPT	Yellowish grey highly weathered fractured rock	>100														
3.30-4.30		Light grey and light brown weathered severely jointed rock															
4.30-5.30		Light grey and light brown weathered severely jointed rock															

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TABLE 13 SHEAR STRENGTH PARAMETERS FOR DIFFERENT LAYERS – M2

TNSCB, MIG, PERUMBAKKAM, Ground water table = 1.00m to 1.40m (March-April 2013)

Borehole BH13 (GL = 1.688m RL)

Depth Below GL	Soil	N	Design N''	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.30m	Yellowish grey silty clay with few stones, LI = 0.163	10	10		c_u = 5.0 t/m²	59	m_v=1/(42N)m²/t
1.30m to 1.90m	Greyish brown sandy silty clay with stones, LI = 0.028	25	25		c_u = 12 t/m²	43	m_v=1/(44N)m²/t
1.90m to 3.20m	Greyish brown clayey silty fine to coarse sand with sandy clay lumps	47	45	ϕ = 37°			C using q_c= 26 N t/m²
3.20m to 5.50m	Greyish brown dirty fine to coarse sand with weathered stones (weathered disintegrated rock)	>100	100	ϕ = 42°			C using q_c= 30 N t/m²
5.50m to 6.30m	Yellowish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
6.30m to 8.00m	Brownish grey highly / completely weathered severely jointed rock						
8.00m to 8.50m	Br grey highly weathered severely jointed rock						

Borehole BH14 (GL = 1.451m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.40m	Yellowish grey silty clay with roots in the top 0.40m, LI = 0.129 to 0.141	5	5		c_u = 3.0 t/m²	61.3	m_v=1/(42N)m²/t
1.40m to 2.20m	Yellowish grey silty clay with white stones and gravel, LI = 0.186	17	15		c_u = 7.5 t/m²	60.9	m_v=1/(42N)m²/t
2.20m to 3.00m	Greyish brown clayey silty sand with sandy clay lumps & weathered stones	25	25	ϕ = 32°			C using q_c= 22 N t/m²
3.00m to 4.00m	Greyish brown dirty fine to coarse sand with weathered stones	82	70	ϕ = 40°			C using q_c= 24 N t/m²
4.00m to 5.00m	Brownish grey dirty fine to coarse sand with weathered stones	>100	100	ϕ = 42°			C using q_c= 26 N t/m²
5.00m to 5.70m	Greyish brown highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
5.70m to 8.20m	Greyish brown highly weathered severely jointed rock						
8.20m to 9.00m	Brownish grey highly weathered closely jointed rock (Granitic gneiss)						

Borehole BH15 (GL = 1.339m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.50m	Brownish grey silty clay with roots						
0.50m to 1.70m	Yellowish grey silty clay, LI=0.145 to 0.156	8	8		c_u = 5.0 t/m²	63.0	m_v=1/(42N)m²/t
1.70m to 2.30m	Greyish brown clayey silty sand with weathered stones	21	20	ϕ = 32.0°			C using q_c= 24 N t/m²
2.30m to 3.20m	Yellowish grey dirty fine to coarse sand with sandy clay lumps	84 to >100	80	ϕ = 41°			C using q_c= 26 N t/m²
3.20m to 5.60m	Brownish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
5.60m to 6.80m	Brownish grey completely weathered severely jointed rock						
6.80m to 7.70m	Greyish partly weathered jointed rock (granitic gneiss)						

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Borehole BH16 (GL = 1.240m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.50m	Yellowish grey silty clay (dry)						
0.50m to 2.10m	Yellowish grey and brown silty clay with few stones, LI = 0.145 to 0.156	10,19	12		c_u = 6.0 t/m²	63.0	m_v=1/(42N)m²/t
2.10m to 3.00m	Yellowish grey clayey silty sand with sandy clay lumps	41	40	ϕ = 37°			C using q_c= 24 N t/m²
3.00m to 3.80m	Brownish grey dirty fine to medium sand with sandy clay lumps	82	80	ϕ = 40°			C using q_c= 26 N t/m²
3.80m to 4.70m	Greyish dirty fine to coarse sand with weathered stones (wdr)	>100	100	ϕ = 42°			C using q_c= 30 N t/m²
4.70m to 5.80m	Brownish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
5.80m to 8.10m	Yellowish grey highly / completely weathered calcareous sandstone						
8.10m to 9.20m	Brownish grey dirty fine to coarse sand with weathered stones						
9.20m to 10.20m	Greyish partly weathered and severely jointed rock						

Borehole BH17 (GL = 1.492m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strengtn c_u	PI %	Compressibility
0.00m to 0.50m	Brownish grey silty clay with sand						
0.50m to 1.40m	Brownish grey soft silty clay , LI = 0.628	0	1		c_u = 0.75 t/m²	68.8	
1.40m to 2.30m	Dark grey soft silty clay with gravel and organic material, LI = 0.563	0	1		c_u = 0.75 t/m²	51.5	
2.30m to 3.20m	Greyish clayey silty fine to coarse sand with weathered stones	38	36	ϕ = 35°			C using q_c= 24 N t/m²
3.20m to 4.20m	Brownish grey clayey silty fine to coarse sand with weathered stones	41, >100	50	ϕ = 38°			C using q_c= 24 N t/m²
4.20m to 6.00m	Dark greenish grey completely weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
6.00m to 7.00m	Yellowish grey highly weathered severely jointed rock						

Borehole BH18 (GL = 1.409m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.50m	Yellowish grey silty clay with black patches						
0.50m to 1.40m	Brownish grey silty clay with reddish brown patches, LI = 0.314	2	3		c_u = 1.5 t/m²	52.5	
1.40m to 2.00m	Yellowish grey and brownish silty clay, LI= 0.162	8	8		c_u = 4.0 t/m²	50.0	m_v=1/(42N)m²/t
2.00m to 2.90m	Brownish clayey silty fine to medium sand / sandy silty clay	24	24	ϕ = 32°			C using q_c= 22 N t/m²
2.90m to 3.70m	Greyish brown dirty fine to coarse sand with weathered stones	74	70	ϕ = 40°			C using q_c= 26 N t/m²
3.70m to 4.50m	Yell grey clayey silty fine to coarse sand with weathered stones (wdr)	>100	100	ϕ = 42°			C using q_c= 26 N t/m²
4.50m to 5.50m	Yellowish grey highly / completely weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
5.50m to 6.50m	Greyish brown & grey completely weathered severely jointed rock						
6.50m to 8.50m	Brownish and grey highly weathered severely jointed rock						

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Borehole BH19 (GL = 1.409m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Br grey silty clay with brown & black patches, LI = 0.215					45.5	
0.60m to 1.40m	Yellowish grey soft silty clay with reddish brown patches, LI = 0.45	2	2		c_u = 1.0 t/m²	44.7	
1.40m to 2.40m	Greyish soft silty clay with reddish brown patches, LI = 0.762	0	1		c_u = 0.75 t/m²	28.1	
2.40m to 4.00m	Brownish grey dirty fine to coarse sand weathered stones	31, 44	32	ϕ = 34°			C using q_c= 24 N t/m²
4.00m to 5.50m	Brownish grey completely weathered / highly weathered fractured rock	>100	100	ϕ = 42°			C using q_c= 28 N t/m²
5.50m to 6.70m	Brownish highly weathered severely jointed rock (siltstone)	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
6.70m to 7.50m	Light brownish and light grey widely jointed hard rock (siltstone)						

Borehole BH20 (GL = 1.250m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Yellowish grey silty clay, LI = 0.249					42.9	
0.60m to 1.40m	Light grey very soft silty clay with reddish brown patches, LI = 0.431	0	1		c_u = 0.75 t/m²	48.0	
1.40m to 2.60m	Brownish grey silty clay with gravel and sand, LI = 0.155	10	10		c_u = 5.0 t/m²	49.0	m_v=1/(42N)m²/t
2.60m to 3.40m	Yellowish grey clayey silty fine to coarse sand with weathered stones	>50	60	ϕ = 38°			C using q_c= 26 N t/m²
3.40m to 4.80m	Yellowish grey completely / highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
4.80m to 6.20m	Light brownish grey weathered closely jointed rock						
6.20m to 7.10m	Light brown and grey widely jointed hard rock (siltstone)						

Borehole BH21 (GL = 1.354m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Yellowish grey medium stiff silty clay, LI = 0.083					46	
0.60m to 1.40m	Yellowish grey soft silty clay with yellow patches, LI = 0.299	2	2		c_u = 1.5 t/m²	56.8	
1.40m to 1.90m	Lt grey soft silty clay with reddish brown patches	7	7		c_u = 3.5 t/m²		
1.90m to 2.30m	Yell brown and grey sandy silty clay with gravel , LI = 0.099		12		c_u = 6.0 t/m²	31.2	m_v=1/(48N)m²/t
2.30m to 4.00m	Yell grey clayey silty sand with sandy clay lumps and weathered stones	44, 49	45	ϕ = 37°			C using q_c= 24 N t/m²
4.00m to 4.50m	Yellowish grey dirty fine to coarse sand	>100	100	ϕ = 42°			C using q_c= 28 N t/m²
4.50m to 5.50m	Yellowish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
5.50m to 8.10m	Greyish weathered severely jointed rock						
8.10m to 8.50m	Brownish & grey weathered closely jointed rock						

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Borehole BH22 (GL = 1.267m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 1.30m	Yellowish grey silty clay, LI = 0.24	3	3		c_u = 1.5 t/m²	54.1	
1.30m to 2.60m	Dark grey soft clay with reddish brown patches, LI = 0.509	0	1		c_u = 0.75 t/m²	73.8	
2.60m to 3.40m	Black organic sandy clay	0	1		c_u = 0.75 t/m²		
3.40m to 4.00m	Dark greenish grey dirty fine to medium sand	17	18	ϕ = 32°			C using q_c= 22 N t/m²
4.00m to 4.80m	Dark brownish grey dirty fine to coarse sand with weathered stones	>50	60	ϕ = 38°			C using q_c= 28 N t/m²
4.80m to 5.60m	Brownish grey dirty fine to coarse sand with weathered stones	>100	100	ϕ = 42°			C using q_c= 30 N t/m²
5.60m to 6.70m	Brownish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
6.70m to 9.10m	Brownish and grey highly weathered severely jointed rock						
9.10m to 9.70m	Br and grey weathered closely jointed rock						

Borehole BH23 (GL = 1.200m RL)

Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.60m	Yellowish grey silty clay, LI=0.136					43.4	
0.60m to 2.20m	Light brownish grey soft silty clay with yellow patches, LI = 0.435 to 0.911	0	1		c_u = 0.75 t/m²	68-74	
2.20m to 3.50m	Dark grey very soft silty clay with medium sand patches and decayed wood	0, 3	2		c_u = 1.0 t/m²	43.2	
3.50m to 4.60m	Dark yellowish grey dirty fine to coarse sand weathered stones	100	75	ϕ = 40°			C using q_c= 28 N t/m²
4.60m to 5.50m	Dark yellowish grey completely weathered fractured rock	>100, RB	150		c_u = 75 t/m²		C using q_c= 30 N t/m²
5.50m to 6.30m	Yellowish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
6.30m to 8.30m	Brownish and grey weathered severely jointed rock						

Borehole BH24 (GL = 1.295m RL)

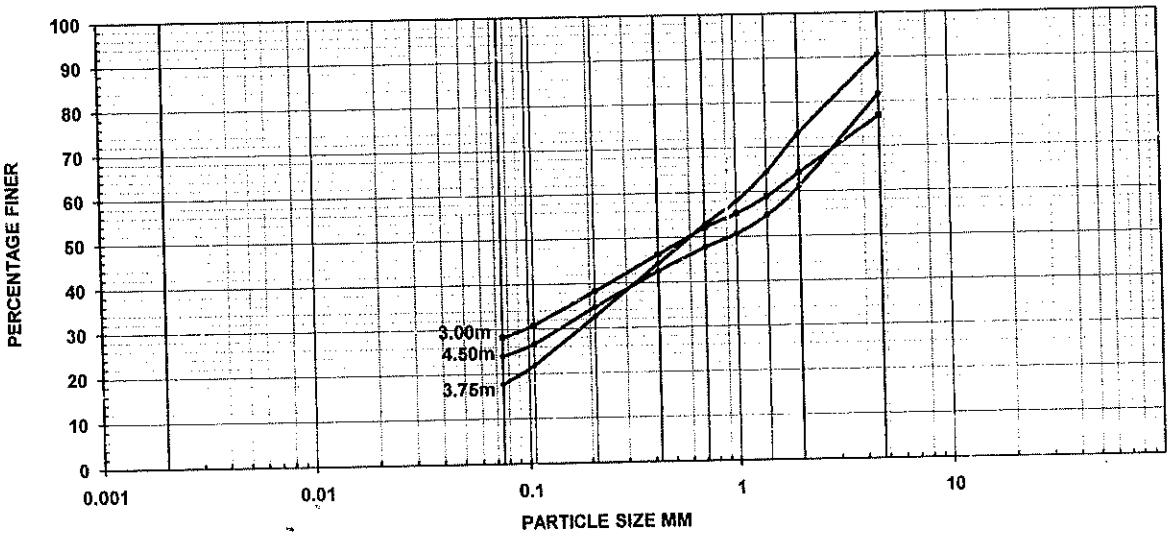
Depth Below GL	Soil	N	Design N	Angle of friction	Shear Strength c_u	PI %	Compressibility
0.00m to 0.50m	Yellowish grey silty clay, LI = 0.046					46.1	
0.50m to 1.80m	Light brownish grey soft silty clay with few stones, LI = 0.544	0	1		c_u = 0.75 t/m²	66.4	
1.80m to 2.40m	Light grey soft silty clay, LI = 1.07	0	1		c_u = 0.50 t/m²	60.1	
2.40m to 2.80m	Yell grey dirty fine to coarse sand with w. stones	>50	60	ϕ = 38°			C using q_c= 26 N t/m²
2.80m to 3.40m	Yellowish grey highly weathered fractured rock	RB	200		c_u = 100 t/m²		C using q_c= 35 N t/m²
3.40m to 5.40m	Light grey and light brown weathered severely jointed rock						

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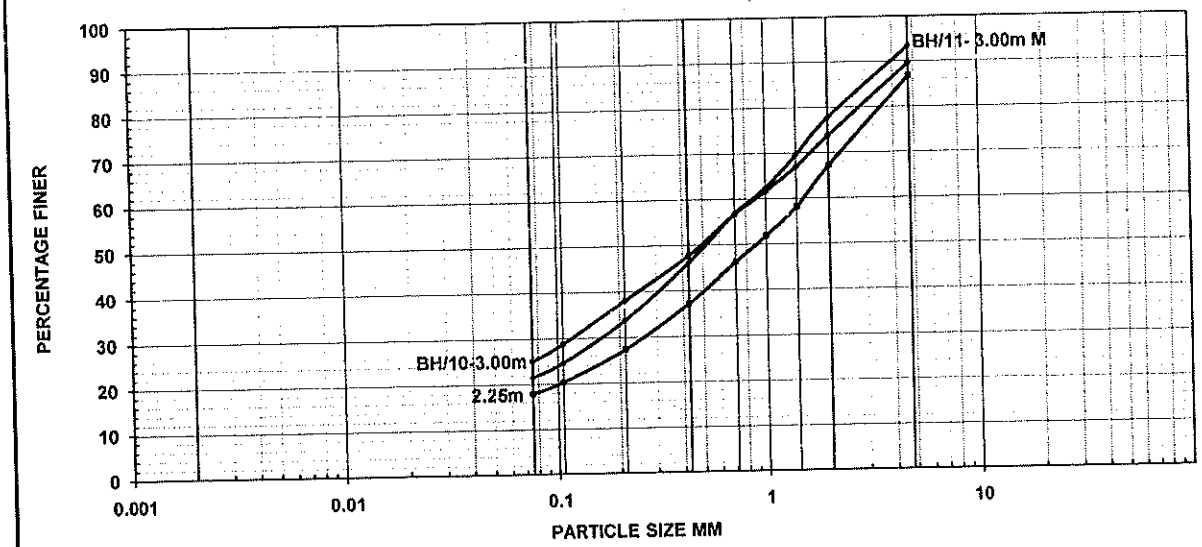
ANNEXURE G1

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Residential Building, Mogapair**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/9	3.00m		100.0	76.9	64.3	46.3	28.2		23.1	12 6	18.0	18.1	28.2		GCS	0.586	14.684	0.860
BH/9	3.75m		100.0	90.8	73.1	44.3	17.7		9.2	17.7	28.8	26.6	17.7		GC-SP	0.597	11.381	0.670
BH/9	4.50m		100.0	81.8	61.3	42.6	24.0		18.2	20.5	18.7	18.6	24.0		GC-SW	0.921	14.936	1.066

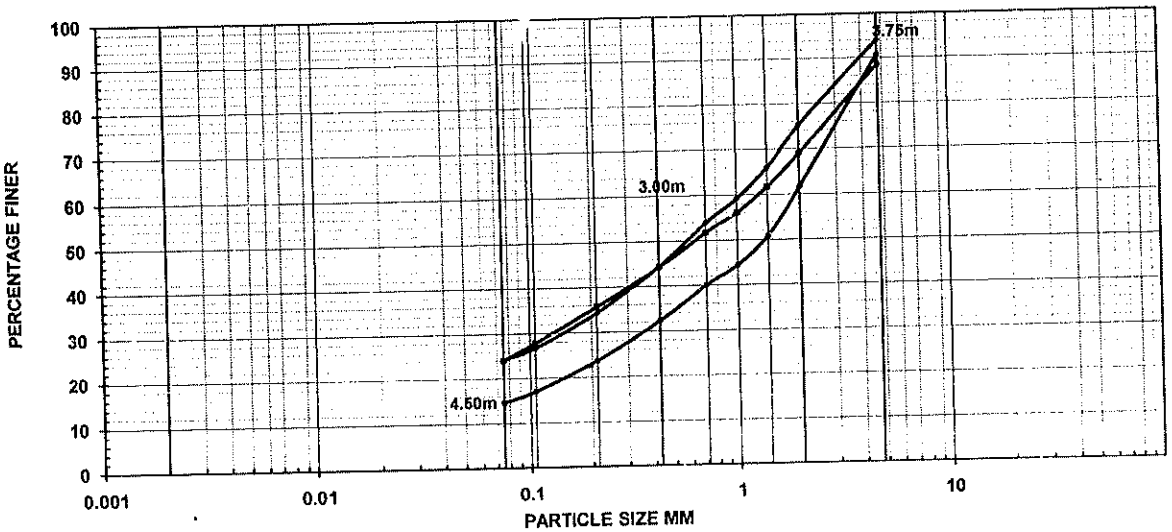


BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/10	2.25m		100.0	86.9	67.2	37.2	17.9		13.1	19.7	30.0	19.3	17.9		GC-SP	0.892	10.701	0.890
BH/10	3.00m		100.0	93.5	77.8	46.1	21.5		6.5	15.7	31.7	24.6	21.5		SC-SP	0.512	8.842	0.795
BH/11	3.00mM		100.0	89.7	73.8	47.7	25.0		10.3	15.9	26.1	22.7	25.0		GCS	0.485	11.729	0.797

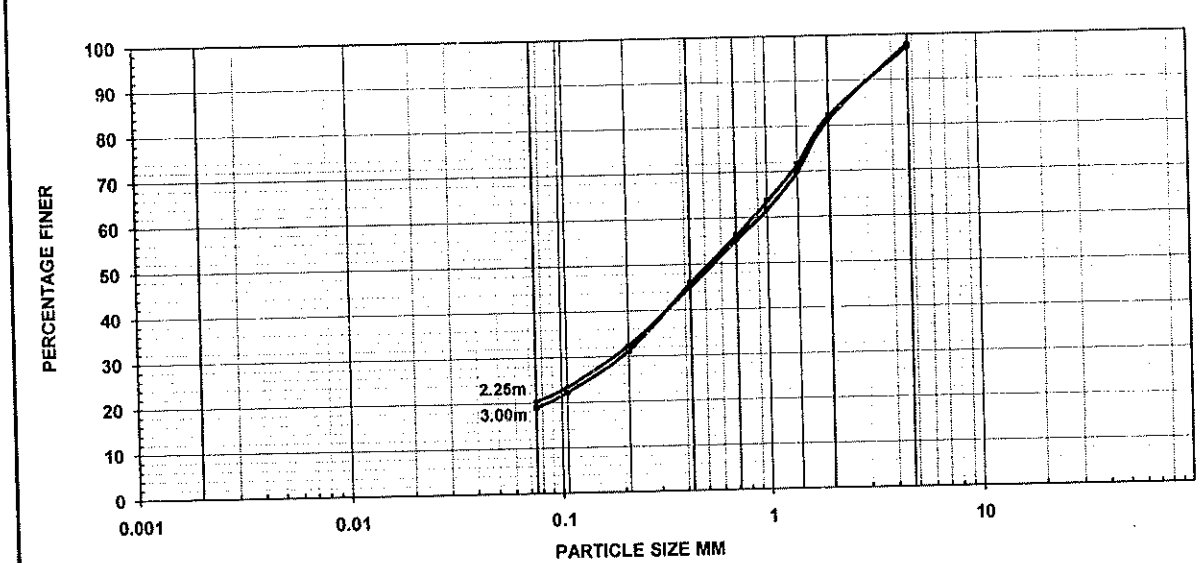
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ANNEXURE G2

GRAIN SIZE DISTRIBUTION CURVES PROJECT: **Residential Building, Mogapair**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	SI	C	CLASS			
BH/12	3.00m		100.0	88.5	69.0	44.3	24.0		11.5	19.5	24.7	20.3	24.0		GCS	0.328	13.751	0.845
BH/12	3.75m		100.0	94.0	75.2	44.4	24.2		6.0	18.8	30.8	20.2	24.2		SC-SP	0.575	9.605	0.871
BH/12	4.50m		100.0	90.7	61.7	32.4	14.6		9.3	29.0	29.3	17.8	14.6		GC-SW	1.335	10.975	1.169

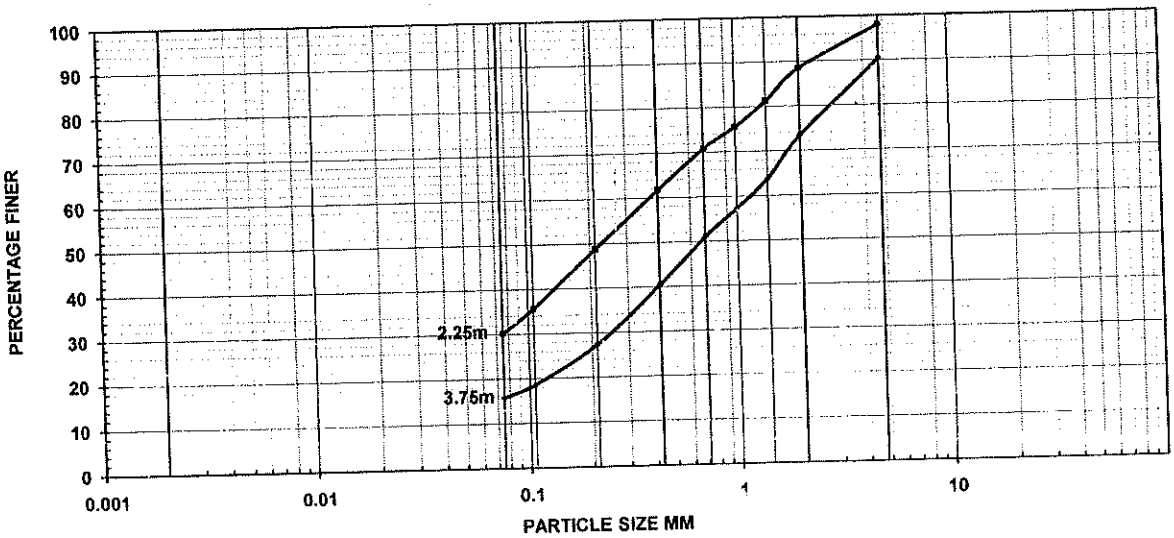


BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	SI	C	CLASS			
BH/13	2.25m		100.0	97.3	82.2	45.9	19.0		2.7	15.1	36.3	26.9	19.0		SC-SP	0.521	7.669	0.770
BH/13	3.00m		100.0	98.0	81.4	45.1	20.4		2.0	16.6	36.3	24.7	20.4		SC-SP	0.545	8.359	0.819

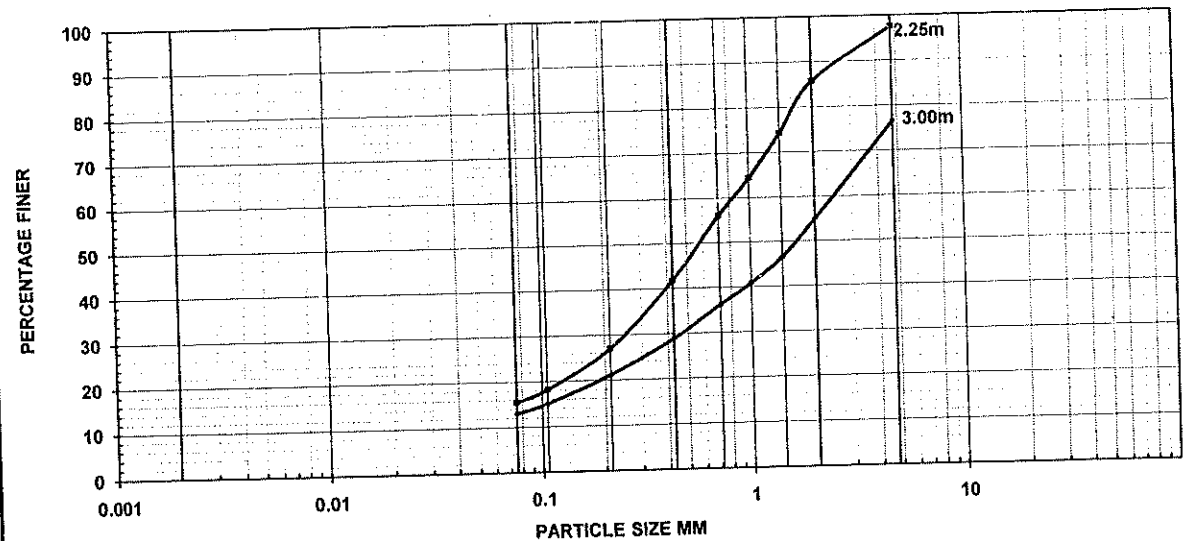
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ANNEXURE G3

GRAIN SIZE DISTRIBUTION CURVES PROJECT: **MIG, Perambakkam**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/14	2.25m		100.0	98.0	88.5	61.8	30.2		2.0	9.5	26.7	31.6	30.2		SC-SP	0.226	6.717	0.648
BH/14	3.75m		100.0	90.5	73.5	40.5	15.8		9.5	17.0	33.0	24.7	15.8		GC-SP	0.670	9.308	0.752

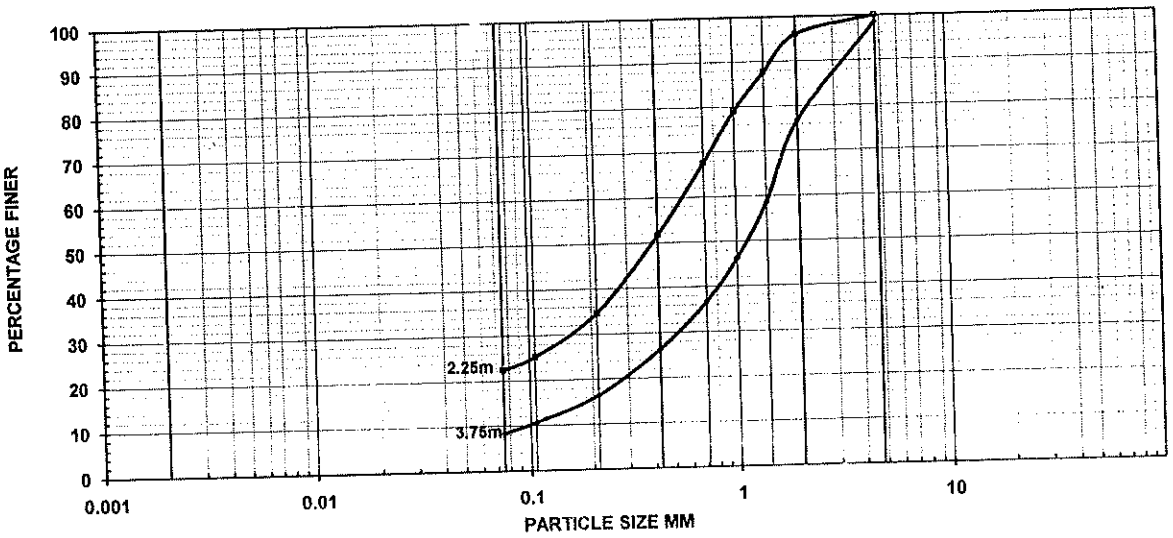


BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/15	2.25m		100.0	97.6	85.8	41.8	15.5		2.4	11.8	44.0	26.3	15.5		SC-SP	0.572	6.377	0.932
BH/15	3.00m		100.0	76.6	55.0	28.9	13.0		23.4	21.6	26.1	15.9	13.0		GC-SW	1.617	10.970	1.425

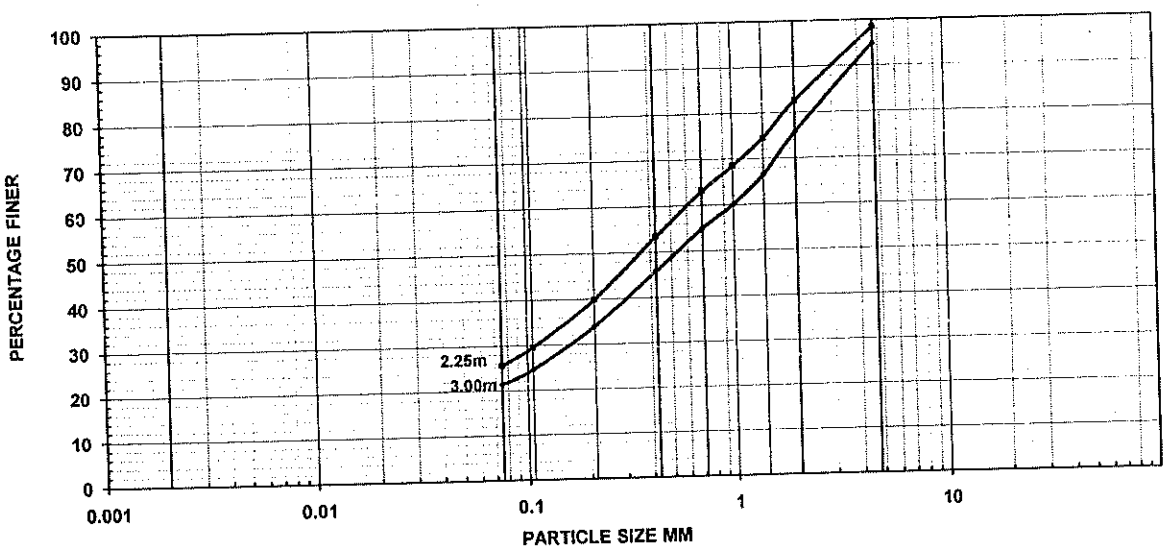
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ANNEXURE G4

GRAIN SIZE DISTRIBUTION CURVES PROJECT: **MIG, Perambakkam**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/16	2.25m		100.0	100.0	96.1	51.7	22.5			3.9	44.4	29.2	22.5		SC-SP	0.397	4.813	0.978
BH/16	3.75m		100.0	98.5	76.9	26.4	8.3		1.5	21.6	50.5	18.1	8.3		SW	1.107	6.720	1.316



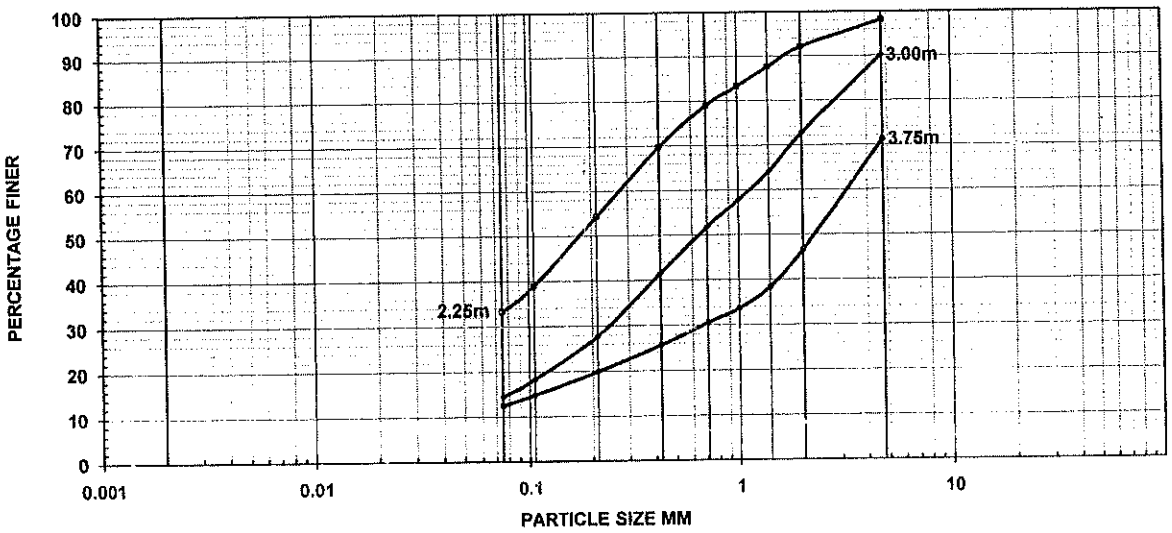
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/17	2.25m		100.0	98.4	82.6	53.4	25.7		1.6	15.8	29.2	27.7	25.7		SC-SP	0.357	8.152	0.696
BH/17	3.00m		100.0	94.9	75.8	46.0	21.4		5.1	19.1	29.8	24.6	21.4		SC-CP	0.533	10.144	0.714

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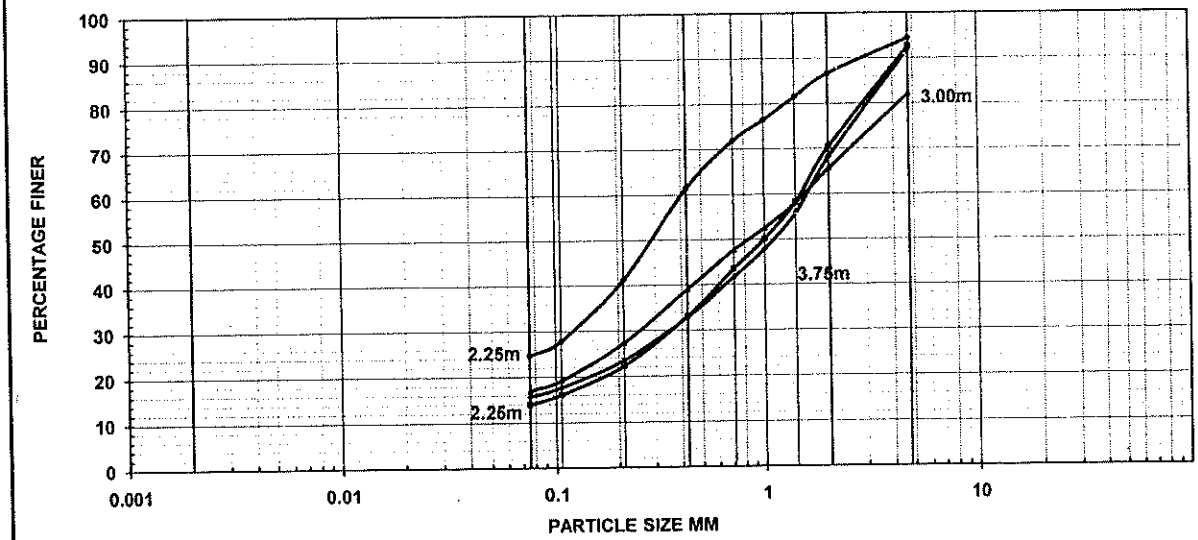
College of Civil Engg., Anna University, Chennai

ANNEXURE G5

GRAIN SIZE DISTRIBUTION CURVES PROJECT: **MIG, Perambakkam**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/18	2.25m		100.0	98.2	92.1	69.8	33.3		1.8	6.1	22.3	36.5	33.3		SC-SP	0.175	4.668	0.717
BH/18	3.00m		100.0	90.3	72.8	41.6	14.5		9.7	17.5	31.2	27.1	14.5		GC-SP	0.646	10.048	0.696
BH/18	3.75m		100.0	71.3	46.7	25.7	12.6		28.7	24.6	21.0	13.1	12.6		GS-SW	2.246	10.786	3.046



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/19	2.25m		100.0	92.7	70.5	33.1	14.0		7.3	22.2	37.4	19.1	14.0		SC-SW	0.995	8.068	0.934
BH/19	3.75m		100.0	92.1	68.3	32.9	15.7		7.9	23.8	35.4	17.2	15.7		SC-SW	1.092	8.554	1.103
BH/20	2.25m		100.0	94.5	86.8	61.5	24.7		5.5	7.7	25.3	36.8	24.7		SC-SP	0.286	4.828	0.794
BH/20	3.00m		100.0	82.3	65.7	39.1	17.0		17.7	16.6	26.6	22.1	17.0		GC-SP	0.837	11.585	0.691

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ANNEXURE U1

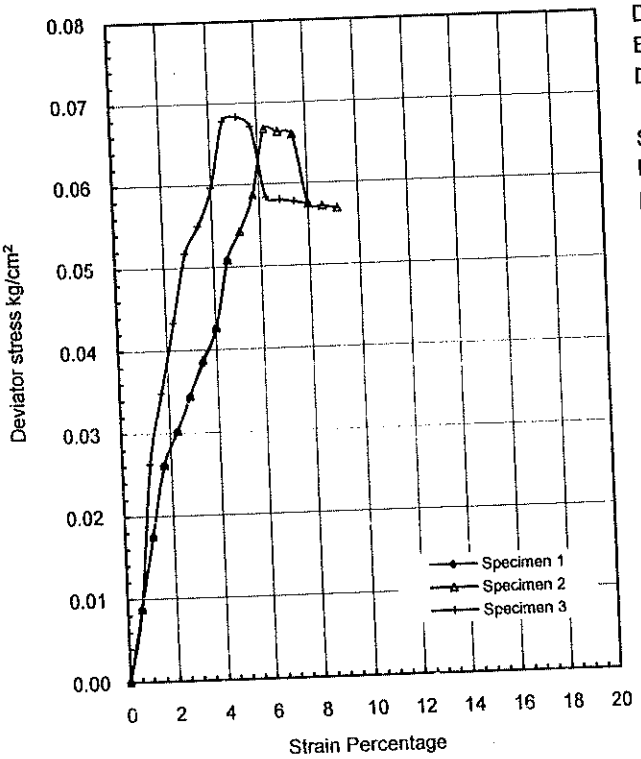
Unconfined Compression Strength Test UCC on soil sample

Project:
MIG Perambakkam, M Block

Date of Test	**27-Mar-13**
Borehole	**BH/24**
Depth	**1.50m**

Soil
Light yellowish grey silty clay with brown patches

Insitu bulk density	1.460 gm/cc
Insitu Dry Density	0.786 gm/cc
Water Content	85.69 %
Liquid Limit %	83.30
Plastic Limit %	23.20
Plasticity Index %	60.10
Liquidity Index	1.04

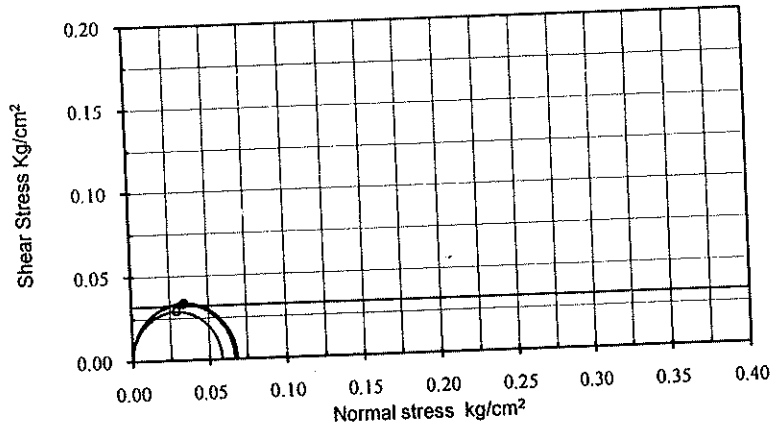


Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm²
Specimen 1	0.058	0.029
Specimen 2	0.067	0.033
Specimen 3	0.068	0.034

Results

Unconfined compression strength q_u	0.064 kg/cm²
Undrained Cohesion c_u	0.032 kg/cm²
Secant Modulus (undrained)	1.61 kg/cm²

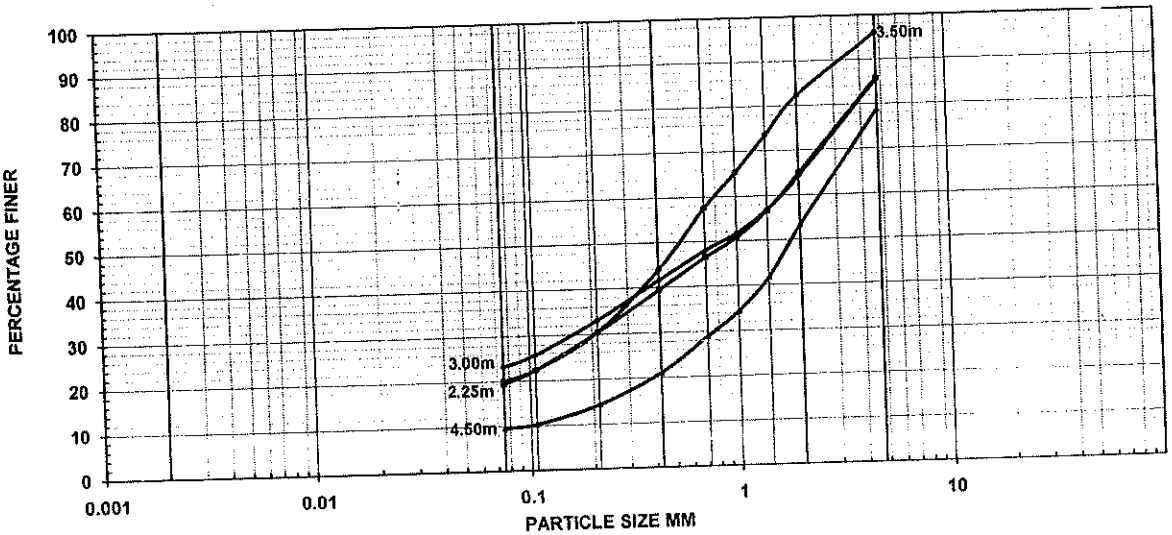


Dept. of Civil Engg.,

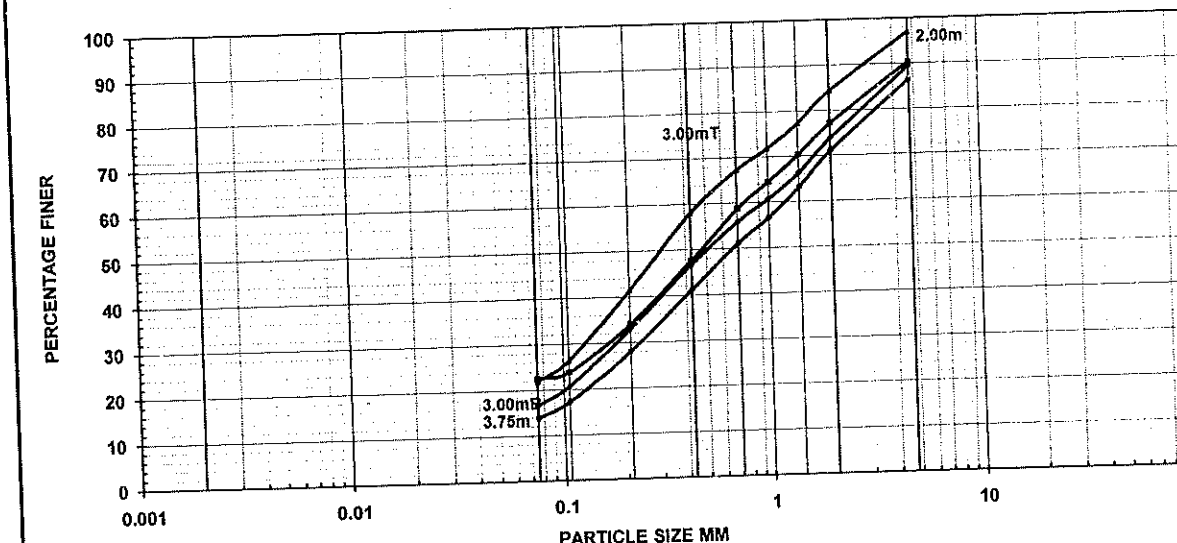
ANNEXURE G6

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: MIG, Perambakkam



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/21	2.25m		100.0	85.0	64.9	39.5	19.4		14.2	20.9	25.4	20.1	19.4		GCS	0.938	13.022	0.929
BH/21	3.00m		100.0	85.5	64.3	41.6	23.2		14.5	21.2	22.7	18.4	23.2		GCS	0.854	13.104	0.978
BH/22	3.50m		100.0	96.1	82.3	43.9	20.1		3.9	13.8	38.4	23.8	20.1		SC-SP	0.535	6.431	0.940
BH/22	4.50m		100.0	78.8	53.3	21.1	9.5		21.2	25.5	32.2	11.6	9.5		GSW	1.807	7.420	1.547



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80	20	4.75	2	0.43	0.08	0	G	CS	MS	FS	Si	C	CLASS			
BH/23	3.00mT		100.0	90.4	77.2	47.6	22.5		9.6	13.2	29.6	25.1	22.5		SC	0.474	7.867	0.704
BH/23	3.00mB		100.0	89.4	73.9	46.8	16.7		10.6	15.5	27.1	30.1	16.7		GC-SP	0.509	10.486	0.562
BH/23	3.75m		100.0	86.5	71.2	41.3	13.9		13.5	15.3	29.9	27.4	13.9		GC-SP	0.667	10.502	0.665
BH/24	2.00m		100.0	97.0	84.3	58.1	21.9		3.0	12.7	26.2	36.2	21.9		SC-SP	0.303	6.383	0.635

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ANNEXURE CS1

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, MIG, Perambakkam

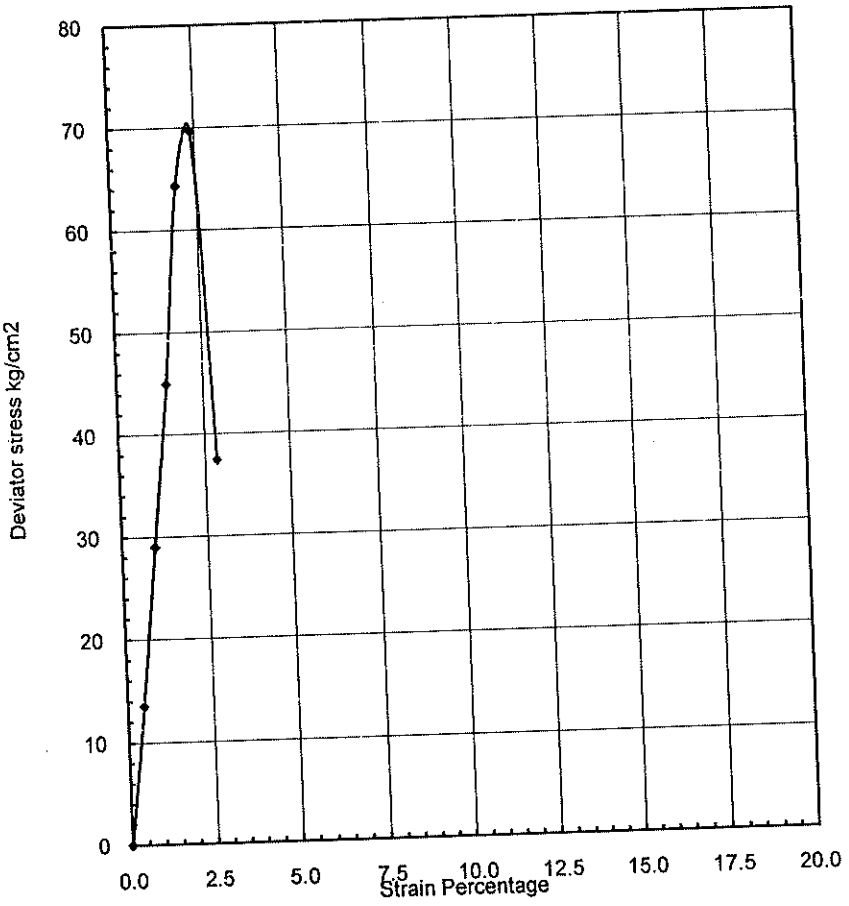
Date of Test	**12-Apr-13**
Borehole	**BH/19**
Depth	**6.50m to 7.50m (S2)**

Description
Light brown and light grey rock

Insitu bulk density	2.758 gm/cc
Insitu Dry Density	2.642 gm/cc
Water Content	4.41 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	70.0



Results

Unconfined compression strength q_u	70.0 kg/cm^2
Young's Modulus (secant)	3145 kg/cm^2

ANNEXURE CS2

Unconfined Compressive Strength Test on Rock Core Sample

Project:
TNSCB, MIG, Perambakkam

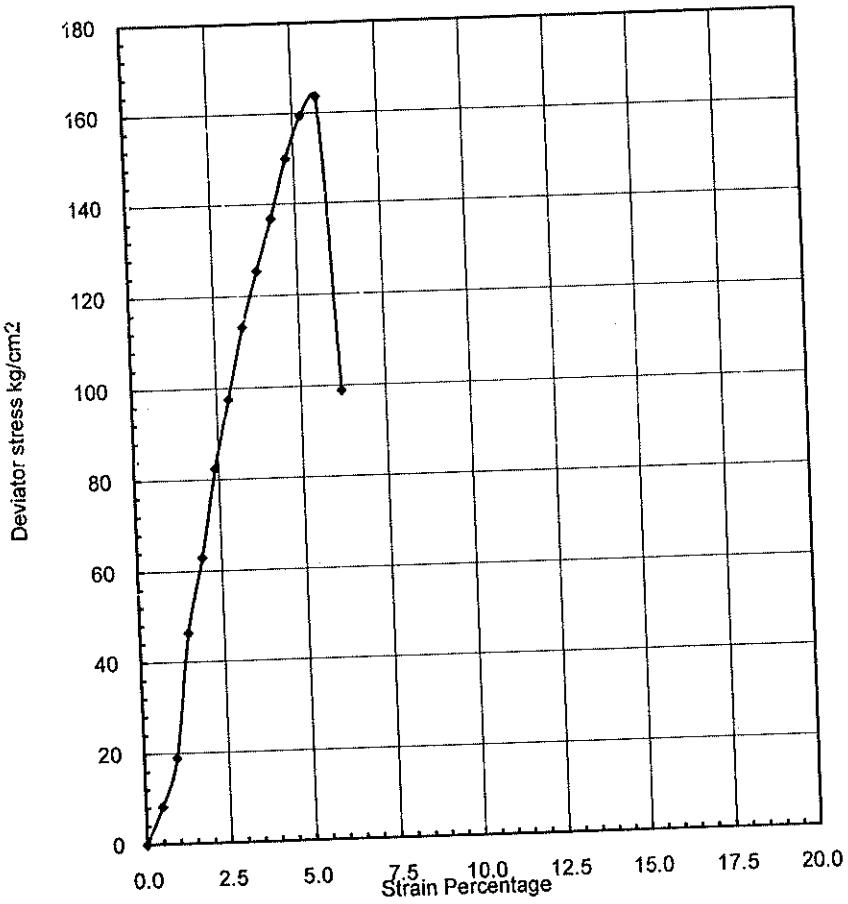
Date of Test	**12-Apr-13**
Borehole	**BH/20**
Depth	**5.80m to 6.80m (S1)**

Description
Light brown and light grey rock

Insitu bulk density	2.477 gm/cc
Insitu Dry Density	2.441 gm/cc
Water Content	1.48 %

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm^2
Specimen 1	0.0	164.0



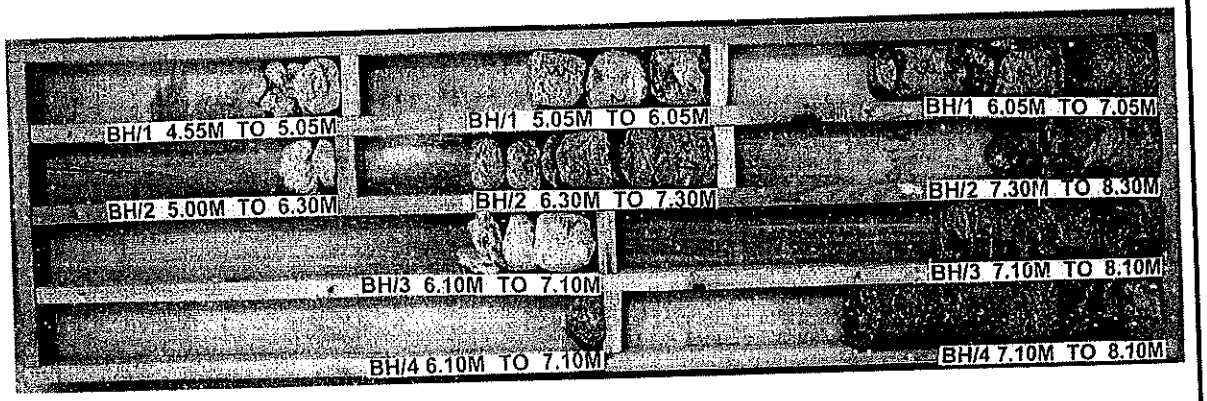
Results

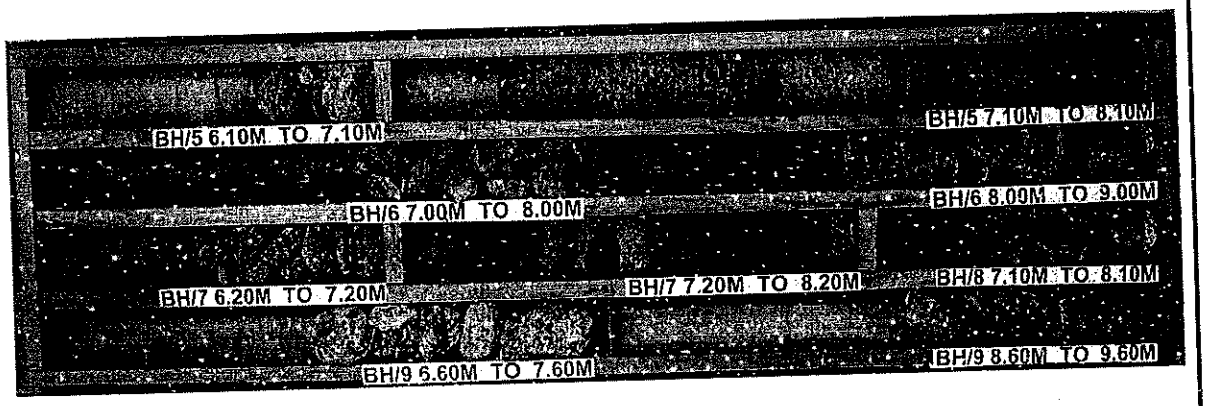
Unconfined compression strength q_u	164.0 kg/cm^2
Young's Modulus (secant)	3242 kg/cm^2

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PLATE 1 CORE SAMPLES FROM BH1 to BH14

CORE SAMPLES FROM BH/1 to BH/14
MIG TENEMENTS, TNSCB, PERUMBAKKAM





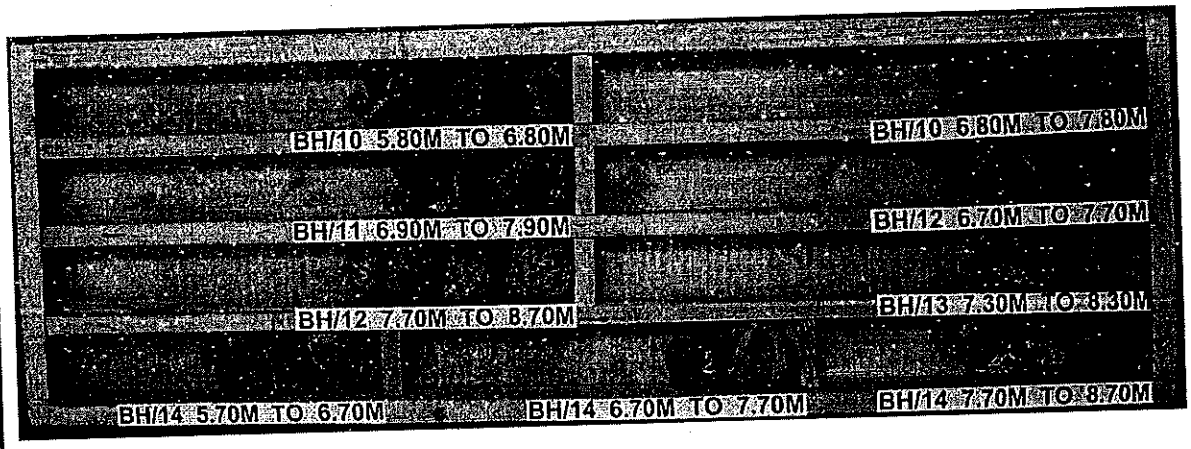
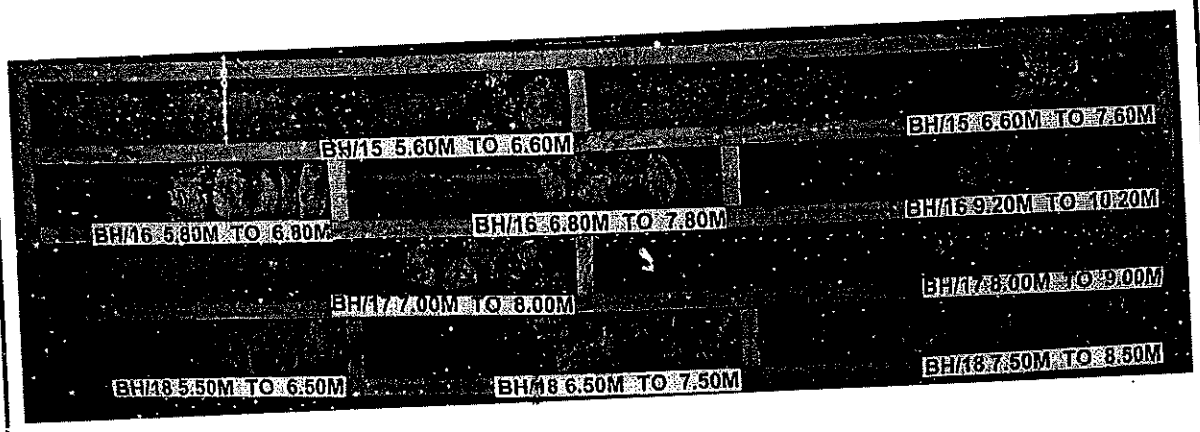
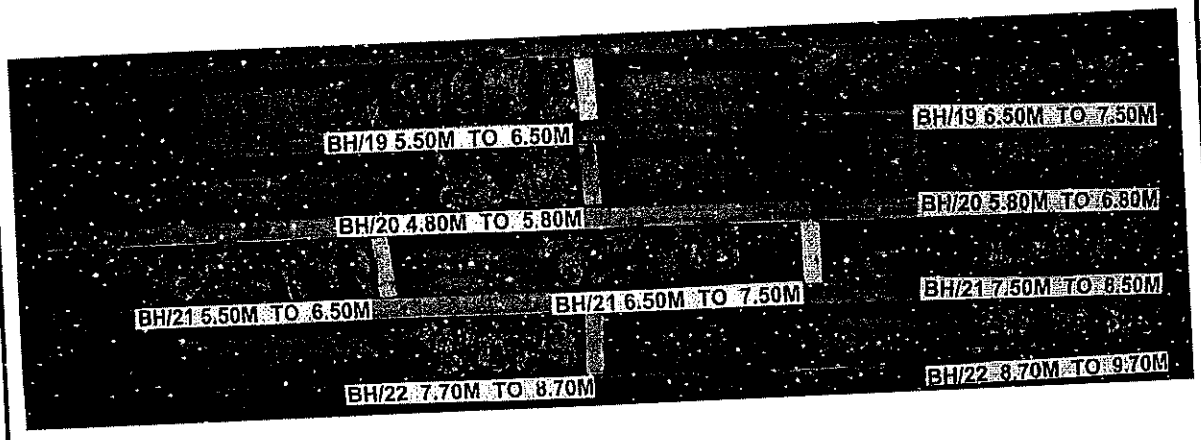
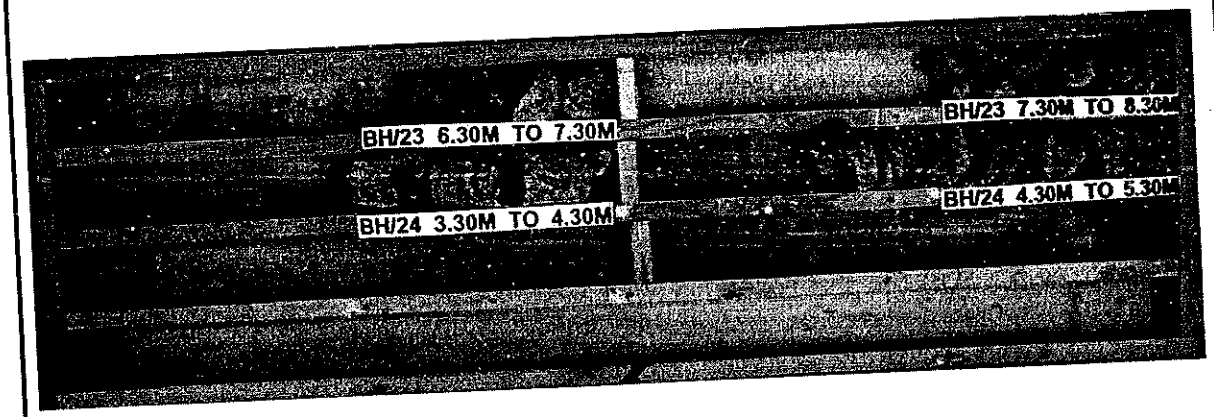


PLATE 2 CORE SAMPLES FROM BH/15 to BH/24

CORE SAMPLES FROM BH/15 to BH/24
MIG TENEMENTS, TNSCB, PERUMBAKKAM







Civil Engg., Annamalai-25

AEE/2

TAKING INITIAL LEVELS WITH AUTO LEVEL AND COMPUTATION OF EARTHWORK FILLING WITH RESPECT TO +2.500m ABOVE MSL FOR MIG PART OF PERUMBAKKAM SCHEME PHASE II UNDER JNNURM

SPONSORED BY

TAMIL NADU SLUM CLEARANCE BOARD
CHENNAI 600 119

INSTITUTE OF REMOTE SENSING
ANNA UNIVERSITY, CHENNAI-25

June 2012

INSTITUTE OF REMOTE SENSING
(TAMIL NADU STATE REMOTE SENSING APPLICATIONS CENTRE)
ANNA UNIVERSITY
CHENNAI - 600 025, INDIA

Prof. M. Ramalingam, B.E., M.S., Ph.D.,
Director

Lr.No.AU/IRS/EV/2012-12 **Date: 21.06.2012**

FILLING QUANTITY IN THE MIG PART OF PHASE II AT PERUMBAKKAM SCHEME FOR TNSCB UNDER JNNURM

Dear Sir,

Ref: Your Lr.No.TNSCB/JUNNURM Dn/171/2007 dated 28.06.2011.

I am to state that the filling quantity with respect to +2.500m above M.S.L. for MIG Part of Phase II at Perumbakkam scheme for TNSCB under JNNURM is 93,881.761m^3. The spot level map of Perumbakkam scheme for TNSCB under JNNURM, MIG Part of Phase II is also enclosed herewith. The computation of filling quantity for other reach is in progress. This is for your kind information please.

21/06/12

DIRECTOR, IRS

Director
Institute of Remote Sensing
Anna University, Chennai-600 025.

To

The Executive Engineer,
JUNNURM Division,
TNSCB, Chennai – 119.

Office: 91-44-2235 8151, 2235 8152, Fax: 91-44-2235 2166, Mobile: 9444444221
Email: dirirs@annauniv.edu, ramalingam.m1@gmail.com

METHODOLOGY ADOPTED

Data used for Reduction of Reduced Level of Bench Marks

Basement Level of the building of Semmenchery scheme :+3.250 m

Reduced Level of Temporary Bench Marks (TBM) near the Scheme

Temporary Bench Mark 1	:	+1.335 m
Temporary Bench Mark 2	:	+1.440 m
Temporary Bench Mark 3	:	+1.340 m
Temporary Bench Mark 4	:	+ 0.700m
Temporary Bench Mark 5	:	+1.780 m
Temporary Bench Mark 6	:	+1.450 m
Temporary Bench Mark 7	:	+1.865 m
Temporary Bench Mark 8	:	+1.365 m
Temporary Bench Mark 9	:	+1.715 m

Formation Level for filling as provided by TNSCB is **+2.500 m**

Computation of Cross Sectional Area Using Simpson's 1/3 Rule

$$A = d/3 \times [(O_0 + O_n) + 4(O_1 + O_3 + O_5 + \ldots\ldots\ldots + O_{n-1}) + 2(O_2 + O_4 + O_6 \ldots\ldots\ldots + O_{n-2})]$$

Where d = spacing between two ordinates

O_i = Ordinate (fill depth) at i^{th} point

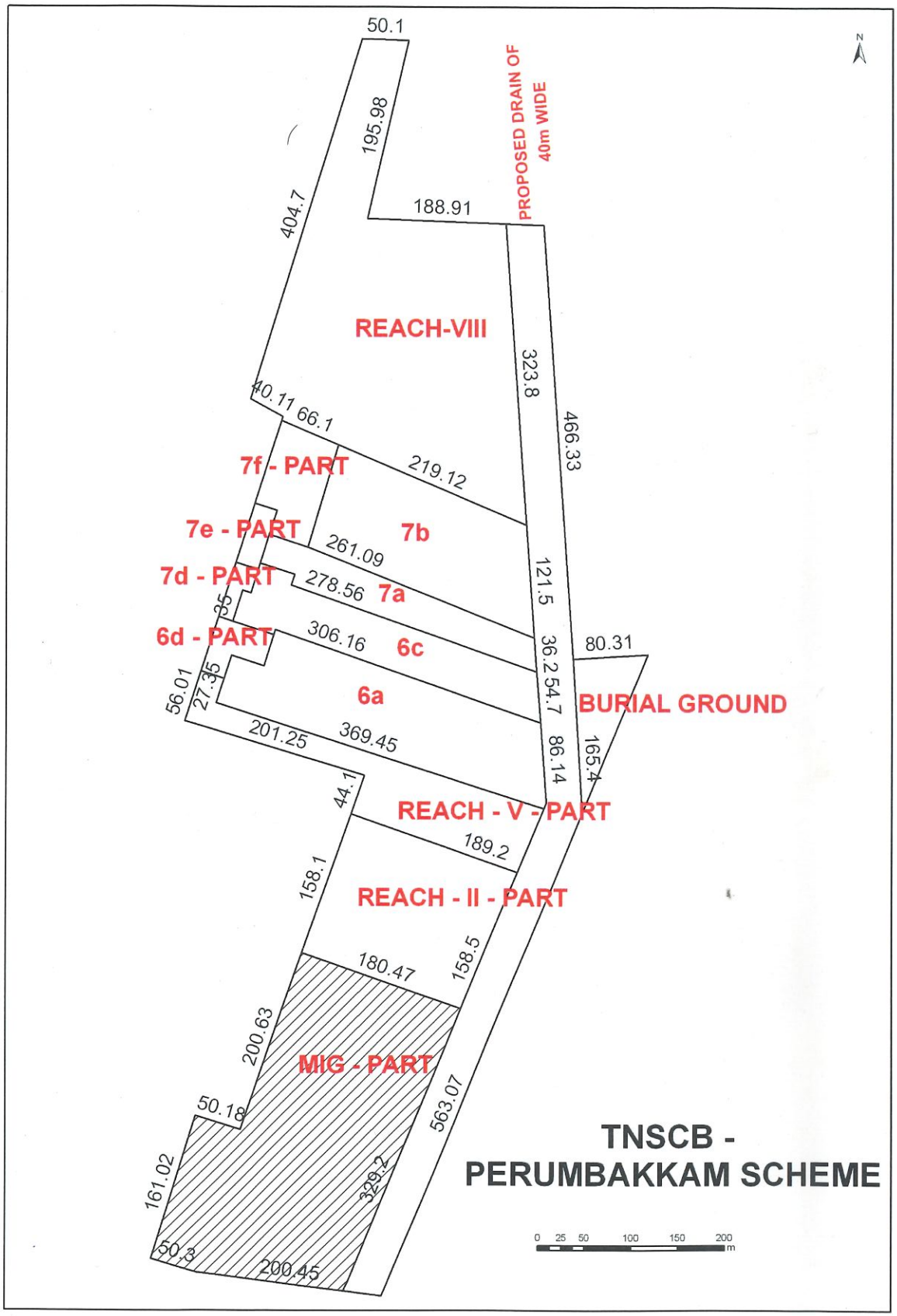
Computation of Volume of Earthwork Using Simpson's 1/3 Rule

$$A = d/3 \times [(A_0 + A_n) + 4(A_1 + A_3 + A_5 + \ldots\ldots\ldots + A_{n-1}) + 2(A_2 + A_4 + A_6 \ldots\ldots\ldots + A_{n-2})]$$

Where d = spacing between two chainages

A_i = Cross Sectional Area at i^{th} chainage

Note: All the reduced levels given are with reference to Mean Sea Level (MSL)



INSTITUTE OF REMOTE SENSING
ANNA UNIVERSITY, CHENNAI 600025

COMPUTATION OF CROSS SECTIONAL AREA FOR PART 1 OF MIG - PART

Chainage (m)	Interval (m)	RL (m)	C.S (m)	Fill Depth (m)	Cross Sectional Area (m^2)		
-10.000	0.000	1.000	0.000	1.500	0.000	60.000	89.017
	5.000	1.040	5.000	1.460	60.000	61.056	1.563
	5.000	1.080	10.000	1.420			
	5.000	1.070	15.000	1.430			
	5.000	1.060	20.000	1.440			**90.580**
	5.000	1.000	25.000	1.500			
	5.000	0.940	30.000	1.560			
	5.000	0.960	35.000	1.540			
	5.000	0.980	40.000	1.520			
	5.000	1.005	45.000	1.495			
	5.000	1.025	50.000	1.475			
	5.000	1.025	55.000	1.475			
	5.000	1.020	60.000	1.480			
	1.056	1.020	61.056	1.480			
-5.000	0.000	1.025	0.000	1.475	0.000	60.000	87.942
	5.000	1.045	5.000	1.455	60.000	61.519	2.233
	5.000	1.060	10.000	1.440			
	5.000	1.060	15.000	1.440			**90.175**
	5.000	1.055	20.000	1.445			
	5.000	1.040	25.000	1.460			
	5.000	1.020	30.000	1.480			
	5.000	1.015	35.000	1.485			
	5.000	1.005	40.000	1.495			
	5.000	1.020	45.000	1.480			
	5.000	1.030	50.000	1.470			
	5.000	1.030	55.000	1.470			
	5.000	1.030	60.000	1.470			
	1.519	1.030	61.519	1.470			
0 R	0.000	1.050	0.000	1.450	0.000	60.000	87.050
	5.000	1.045	5.000	1.455	60.000	61.982	2.894
	5.000	1.040	10.000	1.460			
	5.000	1.045	15.000	1.455			**89.944**
	5.000	1.050	20.000	1.450			
	5.000	1.075	25.000	1.425			
	5.000	1.100	30.000	1.400			
	5.000	1.065	35.000	1.435			
	5.000	1.030	40.000	1.470			
	5.000	1.030	45.000	1.470			
	5.000	1.030	50.000	1.470			
	5.000	1.035	55.000	1.465			
	5.000	1.040	60.000	1.460			
	1.982	1.040	61.982	1.460			

5 R	0.000	1.030	0.000	1.470	0.000	60.000	87.158
	5.000	1.055	5.000	1.445	60.000	62.445	3.557
	5.000	1.080	10.000	1.420			
	5.000	1.065	15.000	1.435			**90.715**
	5.000	1.050	20.000	1.450			
	5.000	1.050	25.000	1.450			
	5.000	1.050	30.000	1.450			
	5.000	1.040	35.000	1.460			
	5.000	1.025	40.000	1.475			
	5.000	1.035	45.000	1.465			
	5.000	1.040	50.000	1.460			
	5.000	1.040	55.000	1.460			
	5.000	1.045	60.000	1.455			
	2.445	1.045	62.445	1.455			
10 R	0.000	1.005	0.000	1.495	0.000	60.000	87.417
	5.000	1.060	5.000	1.440	60.000	62.907	4.230
	5.000	1.115	10.000	1.385			
	5.000	1.085	15.000	1.415			**91.647**
	5.000	1.050	20.000	1.450			
	5.000	1.025	25.000	1.475			
	5.000	1.000	30.000	1.500			
	5.000	1.010	35.000	1.490			
	5.000	1.020	40.000	1.480			
	5.000	1.035	45.000	1.465			
	5.000	1.045	50.000	1.455			
	5.000	1.045	55.000	1.455			
	5.000	1.045	60.000	1.455			
	2.907	1.045	62.907	1.455			
15 R	0.000	1.000	0.000	1.500	0.000	60.000	85.750
	5.000	1.075	5.000	1.425	60.000	63.370	4.887
	5.000	1.155	10.000	1.345			
	5.000	1.175	15.000	1.325			**90.637**
	5.000	1.190	20.000	1.310			
	5.000	1.100	25.000	1.400			
	5.000	1.010	30.000	1.490			
	5.000	1.005	35.000	1.495			
	5.000	1.000	40.000	1.500			
	5.000	1.025	45.000	1.475			
	5.000	1.045	50.000	1.455			
	5.000	1.045	55.000	1.455			
	5.000	1.050	60.000	1.450			
	3.370	1.050	63.370	1.450			
20 R	0.000	0.990	0.000	1.510	0.000	60.000	84.217
	5.000	1.090	5.000	1.410	60.000	63.833	5.558
	5.000	1.190	10.000	1.310			
	5.000	1.260	15.000	1.240			**89.775**
	5.000	1.330	20.000	1.170			

	5.000	1.175	25.000	1.325			
	5.000	1.020	30.000	1.480			
	5.000	1.000	35.000	1.500			
	5.000	0.975	40.000	1.525			
	5.000	1.010	45.000	1.490			
	5.000	1.040	50.000	1.460			
	5.000	1.045	55.000	1.455			
	5.000	1.050	60.000	1.450			
	3.833	1.050	63.833	1.450			
25 R	0.000	1.045	0.000	1.455	0.000	60.000	85.408
	5.000	1.085	5.000	1.415	60.000	64.296	6.240
	5.000	1.130	10.000	1.370			
	5.000	1.155	15.000	1.345			**91.648**
	5.000	1.180	20.000	1.320			
	5.000	1.115	25.000	1.385			
	5.000	1.050	30.000	1.450			
	5.000	1.030	35.000	1.470			
	5.000	1.005	40.000	1.495			
	5.000	1.025	45.000	1.475			
	5.000	1.045	50.000	1.455			
	5.000	1.050	55.000	1.450			
	5.000	1.050	60.000	1.450			
	4.296	1.045	64.296	1.455			
30 R	0.000	1.095	0.000	1.405	0.000	60.000	86.825
	5.000	1.080	5.000	1.420	60.000	64.759	6.924
	5.000	1.065	10.000	1.435			
	5.000	1.045	15.000	1.455			**93.749**
	5.000	1.025	20.000	1.475			
	5.000	1.050	25.000	1.450			
	5.000	1.075	30.000	1.425			
	5.000	1.055	35.000	1.445			
	5.000	1.030	40.000	1.470			
	5.000	1.040	45.000	1.460			
	5.000	1.045	50.000	1.455			
	5.000	1.050	55.000	1.450			
	5.000	1.050	60.000	1.450			
	4.759	1.040	64.759	1.460			
35 R	0.000	1.055	0.000	1.445	0.000	60.000	87.517
	5.000	1.045	5.000	1.455	60.000	65.000	7.313
	5.000	1.035	10.000	1.465	65.000	65.222	0.326
	5.000	1.030	15.000	1.470			**95.156**
	5.000	1.020	20.000	1.480			
	5.000	1.035	25.000	1.465			
	5.000	1.050	30.000	1.450			
	5.000	1.050	35.000	1.450			
	5.000	1.050	40.000	1.450			
	5.000	1.045	45.000	1.455			

	5.000	1.040	50.000	1.460			
	5.000	1.045	55.000	1.455			
	5.000	1.045	60.000	1.455			
	5.000	1.030	65.000	1.470			
	0.222	1.030	65.222	1.470			
40 R	0.000	1.010	0.000	1.490	0.000	60.000	88.392
	5.000	1.010	5.000	1.490	60.000	65.000	7.375
	5.000	1.005	10.000	1.495	65.000	65.685	1.017
	5.000	1.010	15.000	1.490			**96.784**
	5.000	1.010	20.000	1.490			
	5.000	1.015	25.000	1.485			
	5.000	1.020	30.000	1.480			
	5.000	1.045	35.000	1.455			
	5.000	1.065	40.000	1.435			
	5.000	1.050	45.000	1.450			
	5.000	1.030	50.000	1.470			
	5.000	1.035	55.000	1.465			
	5.000	1.035	60.000	1.465			
	5.000	1.015	65.000	1.485			
	0.685	1.015	65.685	1.485			
45 R	0.000	1.060	0.000	1.440	0.000	60.000	87.400
	5.000	1.050	5.000	1.450	60.000	65.000	7.363
	5.000	1.035	10.000	1.465	65.000	66.148	1.705
	5.000	1.025	15.000	1.475			**96.468**
	5.000	1.015	20.000	1.485			
	5.000	1.025	25.000	1.475			
	5.000	1.030	30.000	1.470			
	5.000	1.050	35.000	1.450			
	5.000	1.065	40.000	1.435			
	5.000	1.065	45.000	1.435			
	5.000	1.055	50.000	1.445			
	5.000	1.050	55.000	1.450			
	5.000	1.040	60.000	1.460			
	5.000	1.015	65.000	1.485			
	1.148	1.015	66.148	1.485			
50 R	0.000	1.105	0.000	1.395	0.000	60.000	86.550
	5.000	1.085	5.000	1.415	60.000	65.000	7.350
	5.000	1.060	10.000	1.440	65.000	66.611	2.392
	5.000	1.040	15.000	1.460			**96.292**
	5.000	1.015	20.000	1.485			
	5.000	1.030	25.000	1.470			
	5.000	1.040	30.000	1.460			
	5.000	1.055	35.000	1.445			
	5.000	1.065	40.000	1.435			
	5.000	1.075	45.000	1.425			
	5.000	1.080	50.000	1.420			
	5.000	1.065	55.000	1.435			

	5.000	1.045	60.000	1.455			
	5.000	1.015	65.000	1.485			
	1.611	1.015	66.611	1.485			
55 R	0.000	1.070	0.000	1.430	0.000	60.000	87.842
	5.000	1.060	5.000	1.440	60.000	65.000	7.338
	5.000	1.045	10.000	1.455	65.000	67.073	3.068
	5.000	1.015	15.000	1.485			**98.248**
	5.000	0.980	20.000	1.520			
	5.000	1.030	25.000	1.470			
	5.000	1.075	30.000	1.425			
	5.000	1.050	35.000	1.450			
	5.000	1.020	40.000	1.480			
	5.000	1.025	45.000	1.475			
	5.000	1.030	50.000	1.470			
	5.000	1.040	55.000	1.460			
	5.000	1.045	60.000	1.455			
	5.000	1.020	65.000	1.480			
	2.073	1.020	67.073	1.480			
60 R	0.000	1.035	0.000	1.465	0.000	60.000	89.325
	5.000	1.035	5.000	1.465	60.000	65.000	7.338
	5.000	1.030	10.000	1.470	65.000	67.536	3.741
	5.000	0.985	15.000	1.515			**100.404**
	5.000	0.940	20.000	1.560			
	5.000	1.025	25.000	1.475			
	5.000	1.105	30.000	1.395			
	5.000	1.040	35.000	1.460			
	5.000	0.975	40.000	1.525			
	5.000	0.975	45.000	1.525			
	5.000	0.975	50.000	1.525			
	5.000	1.010	55.000	1.490			
	5.000	1.040	60.000	1.460			
	5.000	1.025	65.000	1.475			
	2.536	1.025	67.536	1.475			
65 R	0.000	1.015	0.000	1.485	0.000	60.000	89.617
	5.000	1.020	5.000	1.480	60.000	65.000	7.438
	5.000	1.020	10.000	1.480	65.000	67.999	4.469
	5.000	1.000	15.000	1.500			**101.524**
	5.000	0.975	20.000	1.525			
	5.000	1.025	25.000	1.475			
	5.000	1.075	30.000	1.425			
	5.000	1.025	35.000	1.475			
	5.000	0.980	40.000	1.520			
	5.000	0.975	45.000	1.525			
	5.000	0.970	50.000	1.530			
	5.000	0.995	55.000	1.505			
	5.000	1.015	60.000	1.485			
	5.000	1.010	65.000	1.490			

	2.999	1.010	67.999	1.490			
70 R	0.000	0.990	0.000	1.510	0.000	60.000	90.117
	5.000	1.000	5.000	1.500	60.000	65.000	7.538
	5.000	1.005	10.000	1.495	65.000	68.462	5.210
	5.000	1.010	15.000	1.490			**102.865**
	5.000	1.010	20.000	1.490			
	5.000	1.025	25.000	1.475			
	5.000	1.040	30.000	1.460			
	5.000	1.010	35.000	1.490			
	5.000	0.980	40.000	1.520			
	5.000	0.970	45.000	1.530			
	5.000	0.960	50.000	1.540			
	5.000	0.975	55.000	1.525			
	5.000	0.990	60.000	1.510			
	5.000	0.995	65.000	1.505			
	3.462	0.995	68.462	1.505			
75 R	0.000	1.005	0.000	1.495	0.000	60.000	90.525
	5.000	1.010	5.000	1.490	60.000	65.000	7.663
	5.000	1.015	10.000	1.485	65.000	68.925	5.956
	5.000	1.010	15.000	1.490			**104.144**
	5.000	1.000	20.000	1.500			
	5.000	1.015	25.000	1.485			
	5.000	1.030	30.000	1.470			
	5.000	0.990	35.000	1.510			
	5.000	0.945	40.000	1.555			
	5.000	0.960	45.000	1.540			
	5.000	0.970	50.000	1.530			
	5.000	0.965	55.000	1.535			
	5.000	0.960	60.000	1.540			
	5.000	0.975	65.000	1.525			
	3.925	0.990	68.925	1.510			
80 R	0.000	1.015	0.000	1.485	0.000	60.000	91.075
	5.000	1.020	5.000	1.480	60.000	65.000	7.788
	5.000	1.020	10.000	1.480	65.000	69.388	6.725
	5.000	1.005	15.000	1.495			**105.588**
	5.000	0.985	20.000	1.515			
	5.000	1.005	25.000	1.495			
	5.000	1.020	30.000	1.480			
	5.000	0.965	35.000	1.535			
	5.000	0.910	40.000	1.590			
	5.000	0.945	45.000	1.555			
	5.000	0.980	50.000	1.520			
	5.000	0.955	55.000	1.545			
	5.000	0.930	60.000	1.570			
	5.000	0.955	65.000	1.545			
	4.388	0.980	69.388	1.520			

85 R	0.000	1.000	0.000	1.500	0.000	60.000	90.625
	5.000	1.015	5.000	1.485	60.000	65.000	7.750
	5.000	1.025	10.000	1.475	65.000	69.851	7.361
	5.000	1.010	15.000	1.490			**105.736**
	5.000	0.995	20.000	1.505			
	5.000	1.015	25.000	1.485			
	5.000	1.025	30.000	1.475			
	5.000	0.970	35.000	1.530			
	5.000	0.915	40.000	1.585			
	5.000	0.960	45.000	1.540			
	5.000	1.005	50.000	1.495			
	5.000	0.970	55.000	1.530			
	5.000	0.935	60.000	1.565			
	5.000	0.965	65.000	1.535			
	4.851	1.000	69.851	1.500			
90 R	0.000	0.985	0.000	1.515	0.000	70.000	105.567
	5.000	1.005	5.000	1.495	70.000	70.314	0.466
	5.000	1.025	10.000	1.475			
	5.000	1.015	15.000	1.485			**106.033**
	5.000	1.005	20.000	1.495			
	5.000	1.020	25.000	1.480			
	5.000	1.030	30.000	1.470			
	5.000	0.975	35.000	1.525			
	5.000	0.920	40.000	1.580			
	5.000	0.975	45.000	1.525			
	5.000	1.025	50.000	1.475			
	5.000	0.980	55.000	1.520			
	5.000	0.935	60.000	1.565			
	5.000	0.975	65.000	1.525			
	5.000	1.015	70.000	1.485			
	0.314	1.015	70.314	1.485			
95 R	0.000	1.005	0.000	1.495	0.000	70.000	104.792
	5.000	1.020	5.000	1.480	70.000	70.776	1.164
	5.000	1.035	10.000	1.465			
	5.000	1.025	15.000	1.475			**105.956**
	5.000	1.020	20.000	1.480			
	5.000	1.030	25.000	1.470			
	5.000	1.035	30.000	1.465			
	5.000	0.990	35.000	1.510			
	5.000	0.945	40.000	1.555			
	5.000	0.975	45.000	1.525			
	5.000	1.005	50.000	1.495			
	5.000	0.990	55.000	1.510			
	5.000	0.980	60.000	1.520			
	5.000	0.990	65.000	1.510			
	5.000	1.000	70.000	1.500			
	0.776	1.000	70.776	1.500			

100 R	0.000	1.025	0.000	1.475	0.000	70.000	104.225
	5.000	1.035	5.000	1.465	70.000	71.239	1.883
	5.000	1.040	10.000	1.460			
	5.000	1.035	15.000	1.465			**106.108**
	5.000	1.030	20.000	1.470			
	5.000	1.035	25.000	1.465			
	5.000	1.035	30.000	1.465			
	5.000	1.000	35.000	1.500			
	5.000	0.965	40.000	1.535			
	5.000	0.975	45.000	1.525			
	5.000	0.980	50.000	1.520			
	5.000	1.000	55.000	1.500			
	5.000	1.020	60.000	1.480			
	5.000	1.000	65.000	1.500			
	5.000	0.980	70.000	1.520			
	1.239	0.980	71.239	1.520			
105 R	0.000	1.015	0.000	1.485	0.000	70.000	104.583
	5.000	1.030	5.000	1.470	70.000	71.702	2.579
	5.000	1.040	10.000	1.460			
	5.000	1.025	15.000	1.475			**107.162**
	5.000	1.010	20.000	1.490			
	5.000	1.010	25.000	1.490			
	5.000	1.010	30.000	1.490			
	5.000	1.000	35.000	1.500			
	5.000	0.985	40.000	1.515			
	5.000	0.985	45.000	1.515			
	5.000	0.980	50.000	1.520			
	5.000	0.995	55.000	1.505			
	5.000	1.010	60.000	1.490			
	5.000	1.000	65.000	1.500			
	5.000	0.985	70.000	1.515			
	1.702	0.985	71.702	1.515			
110 R	0.000	1.005	0.000	1.495	0.000	70.000	105.092
	5.000	1.020	5.000	1.480	70.000	72.165	3.269
	5.000	1.035	10.000	1.465			
	5.000	1.015	15.000	1.485			**108.361**
	5.000	0.990	20.000	1.510			
	5.000	0.985	25.000	1.515			
	5.000	0.980	30.000	1.520			
	5.000	0.995	35.000	1.505			
	5.000	1.005	40.000	1.495			
	5.000	0.995	45.000	1.505			
	5.000	0.980	50.000	1.520			
	5.000	0.990	55.000	1.510			
	5.000	0.995	60.000	1.505			
	5.000	0.995	65.000	1.505			
	5.000	0.990	70.000	1.510			
	2.165	0.990	72.165	1.510			

115 R	0.000	0.955	0.000	1.545	0.000	70.000	105.892
	5.000	0.985	5.000	1.515	70.000	72.628	3.995
	5.000	1.010	10.000	1.490			
	5.000	1.000	15.000	1.500			**109.887**
	5.000	0.990	20.000	1.510			
	5.000	0.990	25.000	1.510			
	5.000	0.985	30.000	1.515			
	5.000	0.990	35.000	1.510			
	5.000	0.995	40.000	1.505			
	5.000	0.995	45.000	1.505			
	5.000	0.990	50.000	1.510			
	5.000	0.980	55.000	1.520			
	5.000	0.965	60.000	1.535			
	5.000	0.975	65.000	1.525			
	5.000	0.980	70.000	1.520			
	2.628	0.980	72.628	1.520			
120 R	0.000	0.905	0.000	1.595	0.000	70.000	106.925
	5.000	0.945	5.000	1.555	70.000	73.091	4.729
	5.000	0.985	10.000	1.515			
	5.000	0.985	15.000	1.515			**111.654**
	5.000	0.985	20.000	1.515			
	5.000	0.990	25.000	1.510			
	5.000	0.990	30.000	1.510			
	5.000	0.985	35.000	1.515			
	5.000	0.980	40.000	1.520			
	5.000	0.990	45.000	1.510			
	5.000	0.995	50.000	1.505			
	5.000	0.965	55.000	1.535			
	5.000	0.930	60.000	1.570			
	5.000	0.950	65.000	1.550			
	5.000	0.970	70.000	1.530			
	3.091	0.970	73.091	1.530			
125 R	0.000	0.895	0.000	1.605	0.000	70.000	107.275
	5.000	0.935	5.000	1.565	70.000	73.554	5.500
	5.000	0.975	10.000	1.525			
	5.000	0.980	15.000	1.520			**112.775**
	5.000	0.980	20.000	1.520			
	5.000	0.995	25.000	1.505			
	5.000	1.005	30.000	1.495			
	5.000	0.995	35.000	1.505			
	5.000	0.980	40.000	1.520			
	5.000	0.970	45.000	1.530			
	5.000	0.955	50.000	1.545			
	5.000	0.950	55.000	1.550			
	5.000	0.945	60.000	1.555			
	5.000	0.950	65.000	1.550			
	5.000	0.960	70.000	1.540			
	3.554	0.945	73.554	1.555			

130 R	0.000	0.880	0.000	1.620	0.000	70.000	107.775
	5.000	0.925	5.000	1.575	70.000	74.017	6.267
	5.000	0.965	10.000	1.535			
	5.000	0.970	15.000	1.530			**114.042**
	5.000	0.970	20.000	1.530			
	5.000	0.995	25.000	1.505			
	5.000	1.020	30.000	1.480			
	5.000	1.000	35.000	1.500			
	5.000	0.980	40.000	1.520			
	5.000	0.950	45.000	1.550			
	5.000	0.915	50.000	1.585			
	5.000	0.935	55.000	1.565			
	5.000	0.955	60.000	1.545			
	5.000	0.950	65.000	1.550			
	5.000	0.945	70.000	1.555			
	4.017	0.935	74.017	1.565			
135 R	0.000	0.875	0.000	1.625	0.000	70.000	108.492
	5.000	0.920	5.000	1.580	70.000	74.480	7.000
	5.000	0.960	10.000	1.540			
	5.000	0.965	15.000	1.535			**115.492**
	5.000	0.970	20.000	1.530			
	5.000	0.980	25.000	1.520			
	5.000	0.985	30.000	1.515			
	5.000	0.965	35.000	1.535			
	5.000	0.940	40.000	1.560			
	5.000	0.940	45.000	1.560			
	5.000	0.935	50.000	1.565			
	5.000	0.940	55.000	1.560			
	5.000	0.940	60.000	1.560			
	5.000	0.945	65.000	1.555			
	5.000	0.950	70.000	1.550			
	4.480	0.925	74.480	1.575			
140 R	0.000	0.865	0.000	1.635	0.000	70.000	109.375
	5.000	0.910	5.000	1.590	70.000	74.942	7.759
	5.000	0.955	10.000	1.545			
	5.000	0.960	15.000	1.540			**117.134**
	5.000	0.965	20.000	1.535			
	5.000	0.960	25.000	1.540			
	5.000	0.950	30.000	1.550			
	5.000	0.925	35.000	1.575			
	5.000	0.900	40.000	1.600			
	5.000	0.930	45.000	1.570			
	5.000	0.955	50.000	1.545			
	5.000	0.940	55.000	1.560			
	5.000	0.925	60.000	1.575			
	5.000	0.940	65.000	1.560			
	5.000	0.950	70.000	1.550			
	4.942	0.910	74.942	1.590			

145 R	0.000	0.835	0.000	1.665	0.000	70.000	109.433
	5.000	0.905	5.000	1.595	70.000	75.000	7.763
	5.000	0.970	10.000	1.530	75.000	75.405	0.632
	5.000	0.965	15.000	1.535			**117.828**
	5.000	0.960	20.000	1.540			
	5.000	0.950	25.000	1.550			
	5.000	0.940	30.000	1.560			
	5.000	0.935	35.000	1.565			
	5.000	0.925	40.000	1.575			
	5.000	0.940	45.000	1.560			
	5.000	0.950	50.000	1.550			
	5.000	0.930	55.000	1.570			
	5.000	0.910	60.000	1.590			
	5.000	0.935	65.000	1.565			
	5.000	0.955	70.000	1.545			
	5.000	0.940	75.000	1.560			
	0.405	0.940	75.405	1.560			
150 R	0.000	0.805	0.000	1.695	0.000	70.000	109.725
	5.000	0.895	5.000	1.605	70.000	75.000	7.688
	5.000	0.980	10.000	1.520	75.000	75.868	1.332
	5.000	0.970	15.000	1.530			**118.745**
	5.000	0.955	20.000	1.545			
	5.000	0.940	25.000	1.560			
	5.000	0.925	30.000	1.575			
	5.000	0.940	35.000	1.560			
	5.000	0.950	40.000	1.550			
	5.000	0.945	45.000	1.555			
	5.000	0.940	50.000	1.560			
	5.000	0.915	55.000	1.585			
	5.000	0.890	60.000	1.610			
	5.000	0.925	65.000	1.575			
	5.000	0.960	70.000	1.540			
	5.000	0.965	75.000	1.535			
	0.868	0.965	75.868	1.535			
155 R	0.000	0.930	0.000	1.570	0.000	70.000	107.542
	5.000	0.975	5.000	1.525	70.000	75.000	7.638
	5.000	1.015	10.000	1.485	75.000	76.331	2.036
	5.000	0.995	15.000	1.505			**117.216**
	5.000	0.970	20.000	1.530			
	5.000	0.960	25.000	1.540			
	5.000	0.955	30.000	1.545			
	5.000	0.965	35.000	1.535			
	5.000	0.970	40.000	1.530			
	5.000	0.975	45.000	1.525			
	5.000	0.975	50.000	1.525			
	5.000	0.940	55.000	1.560			
	5.000	0.900	60.000	1.600			
	5.000	0.940	65.000	1.560			

	5.000	0.975	70.000	1.525			
	5.000	0.970	75.000	1.530			
	1.331	0.970	76.331	1.530			
160 R	0.000	1.050	0.000	1.450	0.000	70.000	105.642
	5.000	1.050	5.000	1.450	70.000	75.000	7.613
	5.000	1.045	10.000	1.455	75.000	76.794	2.745
	5.000	1.015	15.000	1.485			**116.000**
	5.000	0.980	20.000	1.520			
	5.000	0.980	25.000	1.520			
	5.000	0.980	30.000	1.520			
	5.000	0.985	35.000	1.515			
	5.000	0.990	40.000	1.510			
	5.000	1.000	45.000	1.500			
	5.000	1.005	50.000	1.495			
	5.000	0.960	55.000	1.540			
	5.000	0.910	60.000	1.590			
	5.000	0.950	65.000	1.550			
	5.000	0.985	70.000	1.515			
	5.000	0.970	75.000	1.530			
	1.794	0.970	76.794	1.530			
165 R	0.000	1.030	0.000	1.470	0.000	70.000	104.417
	5.000	1.025	5.000	1.475	70.000	75.000	7.450
	5.000	1.020	10.000	1.480	75.000	77.257	3.363
	5.000	1.015	15.000	1.485			**115.230**
	5.000	1.010	20.000	1.490			
	5.000	1.005	25.000	1.495			
	5.000	0.995	30.000	1.505			
	5.000	1.005	35.000	1.495			
	5.000	1.010	40.000	1.490			
	5.000	1.020	45.000	1.480			
	5.000	1.020	50.000	1.480			
	5.000	1.000	55.000	1.500			
	5.000	0.970	60.000	1.530			
	5.000	0.995	65.000	1.505			
	5.000	1.010	70.000	1.490			
	5.000	1.010	75.000	1.490			
	2.257	1.010	77.257	1.490			
170 R	0.000	1.005	0.000	1.495	0.000	70.000	103.383
	5.000	1.000	5.000	1.500	70.000	75.000	7.288
	5.000	0.990	10.000	1.510	75.000	77.720	3.944
	5.000	1.015	15.000	1.485			**114.615**
	5.000	1.040	20.000	1.460			
	5.000	1.025	25.000	1.475			
	5.000	1.010	30.000	1.490			
	5.000	1.020	35.000	1.480			
	5.000	1.030	40.000	1.470			
	5.000	1.035	45.000	1.465			

	5.000	1.035	50.000	1.465			
	5.000	1.035	55.000	1.465			
	5.000	1.030	60.000	1.470			
	5.000	1.035	65.000	1.465			
	5.000	1.035	70.000	1.465			
	5.000	1.050	75.000	1.450			
	2.720	1.050	77.720	1.450			
175 R	0.000	1.030	0.000	1.470	0.000	70.000	103.592
	5.000	1.045	5.000	1.455	70.000	75.000	7.525
	5.000	1.055	10.000	1.445	75.000	78.183	4.727
	5.000	1.045	15.000	1.455			**115.844**
	5.000	1.035	20.000	1.465			
	5.000	1.020	25.000	1.480			
	5.000	1.000	30.000	1.500			
	5.000	1.020	35.000	1.480			
	5.000	1.035	40.000	1.465			
	5.000	1.035	45.000	1.465			
	5.000	1.035	50.000	1.465			
	5.000	1.005	55.000	1.495			
	5.000	0.970	60.000	1.530			
	5.000	0.975	65.000	1.525			
	5.000	0.975	70.000	1.525			
	5.000	1.015	75.000	1.485			
	3.183	1.015	78.183	1.485			
180 R	0.000	1.050	0.000	1.450	0.000	70.000	104.000
	5.000	1.085	5.000	1.415	70.000	75.000	7.775
	5.000	1.120	10.000	1.380	75.000	78.645	5.540
	5.000	1.075	15.000	1.425			**117.315**
	5.000	1.030	20.000	1.470			
	5.000	1.010	25.000	1.490			
	5.000	0.990	30.000	1.510			
	5.000	1.015	35.000	1.485			
	5.000	1.040	40.000	1.460			
	5.000	1.035	45.000	1.465			
	5.000	1.030	50.000	1.470			
	5.000	0.970	55.000	1.530			
	5.000	0.910	60.000	1.590			
	5.000	0.910	65.000	1.590			
	5.000	0.910	70.000	1.590			
	5.000	0.980	75.000	1.520			
	3.645	0.980	78.645	1.520			

COMPUTATION OF FILLING QUANTITY FOR PART 1 OF MIG - PART				
Chainage (m)	**C/S Area (m^2)**			
-10.000	90.580	-10.000	180 R	**19824.565**
-5.000	90.175			
0 R	89.944			
5 R	90.715			
10 R	91.647			
15 R	90.637			
20 R	89.775			
25 R	91.648			
30 R	93.749			
35 R	95.156			
40 R	96.784			
45 R	96.468			
50 R	96.292			
55 R	98.248			
60 R	100.404			
65 R	101.524			
70 R	102.865			
75 R	104.144			
80 R	105.588			
85 R	105.736			
90 R	106.033			
95 R	105.956			
100 R	106.108			
105 R	107.162			
110 R	108.361			
115 R	109.887			
120 R	111.654			
125 R	112.775			
130 R	114.042			
135 R	115.492			
140 R	117.134			
145 R	117.828			
150 R	118.745			
155 R	117.216			
160 R	116.000			
165 R	115.230			
170 R	114.615			
175 R	115.844			
180 R	117.315			

COMPUTATION OF CROSS SECTIONAL AREA FOR PART 2 OF MIG - PART

Chainage (m)	Interval (m)	RL (m)	C.S (m)	Fill Depth (m)	Cross Sectional Area (m^2)		
	0.000	1.000	0.000	1.500	0.000	100.000	146.375
-10	5.000	1.020	5.000	1.480	100.000	105.000	7.513
	5.000	1.035	10.000	1.465	105.000	108.910	5.855
	5.000	1.065	15.000	1.435			
	5.000	1.095	20.000	1.405			**159.743**
	5.000	1.040	25.000	1.460			
	5.000	0.985	30.000	1.515			
	5.000	1.000	35.000	1.500			
	5.000	1.015	40.000	1.485			
	5.000	1.005	45.000	1.495			
	5.000	0.995	50.000	1.505			
	5.000	1.030	55.000	1.470			
	5.000	1.065	60.000	1.435			
	5.000	1.035	65.000	1.465			
	5.000	1.000	70.000	1.500			
	5.000	1.050	75.000	1.450			
	5.000	1.095	80.000	1.405			
	5.000	1.085	85.000	1.415			
	5.000	1.075	90.000	1.425			
	5.000	1.035	95.000	1.465			
	5.000	0.995	100.000	1.505			
	5.000	1.000	105.000	1.500			
	3.910	1.005	108.910	1.495			
	0.000	1.025	0.000	1.475	0.000	100.000	146.550
-5	5.000	1.040	5.000	1.460	100.000	105.000	7.388
	5.000	1.045	10.000	1.455	105.000	108.724	5.502
	5.000	1.035	15.000	1.465			
	5.000	1.025	20.000	1.475			**159.440**
	5.000	1.045	25.000	1.455			
	5.000	1.065	30.000	1.435			
	5.000	1.035	35.000	1.465			
	5.000	1.000	40.000	1.500			
	5.000	1.010	45.000	1.490			
	5.000	1.020	50.000	1.480			
	5.000	1.020	55.000	1.480			
	5.000	1.015	60.000	1.485			
	5.000	1.020	65.000	1.480			
	5.000	1.020	70.000	1.480			
	5.000	1.035	75.000	1.465			
	5.000	1.045	80.000	1.455			
	5.000	1.060	85.000	1.440			
	5.000	1.075	90.000	1.425			
	5.000	1.050	95.000	1.450			
	5.000	1.025	100.000	1.475			
	5.000	1.020	105.000	1.480			
	3.724	1.025	108.724	1.475			

	0.000	1.050	0.000	1.450	0.000	100.000	147.050
0 L	5.000	1.055	5.000	1.445	100.000	105.000	7.275
	5.000	1.055	10.000	1.445	105.000	108.538	5.165
	5.000	1.005	15.000	1.495			
	5.000	0.955	20.000	1.545			**159.490**
	5.000	1.050	25.000	1.450			
	5.000	1.140	30.000	1.360			
	5.000	1.065	35.000	1.435			
	5.000	0.985	40.000	1.515			
	5.000	1.015	45.000	1.485			
	5.000	1.040	50.000	1.460			
	5.000	1.005	55.000	1.495			
	5.000	0.965	60.000	1.535			
	5.000	1.000	65.000	1.500			
	5.000	1.035	70.000	1.465			
	5.000	1.015	75.000	1.485			
	5.000	0.990	80.000	1.510			
	5.000	1.030	85.000	1.470			
	5.000	1.070	90.000	1.430			
	5.000	1.060	95.000	1.440			
	5.000	1.050	100.000	1.450			
	5.000	1.040	105.000	1.460			
	3.538	1.040	108.538	1.460			
	0.000	1.030	0.000	1.470	0.000	100.000	149.200
5 L	5.000	1.020	5.000	1.480	100.000	105.000	7.350
	5.000	1.005	10.000	1.495	105.000	108.352	4.927
	5.000	1.010	15.000	1.490			
	5.000	1.010	20.000	1.490			**161.477**
	5.000	1.020	25.000	1.480			
	5.000	1.025	30.000	1.475			
	5.000	1.010	35.000	1.490			
	5.000	0.995	40.000	1.505			
	5.000	1.010	45.000	1.490			
	5.000	1.020	50.000	1.480			
	5.000	1.035	55.000	1.465			
	5.000	1.050	60.000	1.450			
	5.000	1.015	65.000	1.485			
	5.000	0.975	70.000	1.525			
	5.000	0.980	75.000	1.520			
	5.000	0.980	80.000	1.520			
	5.000	0.980	85.000	1.520			
	5.000	0.980	90.000	1.520			
	5.000	1.005	95.000	1.495			
	5.000	1.030	100.000	1.470			
	5.000	1.030	105.000	1.470			
	3.352	1.030	108.352	1.470			
	0.000	1.005	0.000	1.495	0.000	100.000	151.600
10 L	5.000	0.980	5.000	1.520	100.000	105.000	7.450
	5.000	0.955	10.000	1.545	105.000	108.166	4.702
	5.000	1.010	15.000	1.490			
	5.000	1.060	20.000	1.440			**163.752**

	5.000	0.985	25.000	1.515			
	5.000	0.905	30.000	1.595			
	5.000	0.955	35.000	1.545			
	5.000	1.000	40.000	1.500			
	5.000	1.000	45.000	1.500			
	5.000	1.000	50.000	1.500			
	5.000	1.065	55.000	1.435			
	5.000	1.130	60.000	1.370			
	5.000	1.025	65.000	1.475			
	5.000	0.915	70.000	1.585			
	5.000	0.945	75.000	1.555			
	5.000	0.970	80.000	1.530			
	5.000	0.930	85.000	1.570			
	5.000	0.890	90.000	1.610			
	5.000	0.950	95.000	1.550			
	5.000	1.005	100.000	1.495			
	5.000	1.015	105.000	1.485			
	3.166	1.015	108.166	1.485			
	0.000	1.000	0.000	1.500	0.000	100.000	149.192
15 L	5.000	0.985	5.000	1.515	100.000	105.000	7.375
	5.000	0.965	10.000	1.535	105.000	107.980	4.425
	5.000	1.000	15.000	1.500			
	5.000	1.035	20.000	1.465			**160.992**
	5.000	0.985	25.000	1.515			
	5.000	0.935	30.000	1.565			
	5.000	0.975	35.000	1.525			
	5.000	1.010	40.000	1.490			
	5.000	1.040	45.000	1.460			
	5.000	1.070	50.000	1.430			
	5.000	1.085	55.000	1.415			
	5.000	1.100	60.000	1.400			
	5.000	1.055	65.000	1.445			
	5.000	1.005	70.000	1.495			
	5.000	0.985	75.000	1.515			
	5.000	0.965	80.000	1.535			
	5.000	0.970	85.000	1.530			
	5.000	0.970	90.000	1.530			
	5.000	1.005	95.000	1.495			
	5.000	1.035	100.000	1.465			
	5.000	1.015	105.000	1.485			
	2.980	1.015	107.980	1.485			
	0.000	0.990	0.000	1.510	0.000	100.000	147.042
20 L	5.000	0.980	5.000	1.520	100.000	105.000	7.300
	5.000	0.970	10.000	1.530	105.000	107.794	4.149
	5.000	0.990	15.000	1.510			
	5.000	1.005	20.000	1.495			**158.491**
	5.000	0.985	25.000	1.515			
	5.000	0.960	30.000	1.540			
	5.000	0.990	35.000	1.510			
	5.000	1.015	40.000	1.485			
	5.000	1.080	45.000	1.420			

	5.000	1.140	50.000	1.360			
	5.000	1.105	55.000	1.395			
	5.000	1.070	60.000	1.430			
	5.000	1.080	65.000	1.420			
	5.000	1.090	70.000	1.410			
	5.000	1.025	75.000	1.475			
	5.000	0.960	80.000	1.540			
	5.000	1.005	85.000	1.495			
	5.000	1.050	90.000	1.450			
	5.000	1.060	95.000	1.440			
	5.000	1.065	100.000	1.435			
	5.000	1.015	105.000	1.485			
	2.794	1.015	107.794	1.485			
	0.000	1.045	0.000	1.455	0.000	100.000	144.533
25 L	5.000	1.015	5.000	1.485	100.000	105.000	7.388
	5.000	0.980	10.000	1.520	105.000	107.608	3.860
	5.000	0.990	15.000	1.510			
	5.000	0.995	20.000	1.505			**155.781**
	5.000	0.980	25.000	1.520			
	5.000	0.960	30.000	1.540			
	5.000	1.000	35.000	1.500			
	5.000	1.035	40.000	1.465			
	5.000	1.105	45.000	1.395			
	5.000	1.170	50.000	1.330			
	5.000	1.185	55.000	1.315			
	5.000	1.200	60.000	1.300			
	5.000	1.150	65.000	1.350			
	5.000	1.100	70.000	1.400			
	5.000	1.050	75.000	1.450			
	5.000	1.000	80.000	1.500			
	5.000	1.030	85.000	1.470			
	5.000	1.065	90.000	1.435			
	5.000	1.045	95.000	1.455			
	5.000	1.025	100.000	1.475			
	5.000	1.020	105.000	1.480			
	2.608	1.020	107.608	1.480			
	0.000	1.095	0.000	1.405	0.000	100.000	142.317
30 L	5.000	1.040	5.000	1.460	100.000	105.000	7.488
	5.000	0.985	10.000	1.515	105.000	107.422	3.585
	5.000	0.985	15.000	1.515			
	5.000	0.985	20.000	1.515			**153.390**
	5.000	0.970	25.000	1.530			
	5.000	0.955	30.000	1.545			
	5.000	1.005	35.000	1.495			
	5.000	1.055	40.000	1.445			
	5.000	1.130	45.000	1.370			
	5.000	1.200	50.000	1.300			
	5.000	1.265	55.000	1.235			
	5.000	1.330	60.000	1.170			
	5.000	1.220	65.000	1.280			
	5.000	1.105	70.000	1.395			

	5.000	1.070	75.000	1.430			
	5.000	1.035	80.000	1.465			
	5.000	1.055	85.000	1.445			
	5.000	1.075	90.000	1.425			
	5.000	1.030	95.000	1.470			
	5.000	0.985	100.000	1.515			
	5.000	1.020	105.000	1.480			
	2.422	1.020	107.422	1.480			
	0.000	1.055	0.000	1.445	0.000	100.000	149.242
35 L	5.000	1.025	5.000	1.475	100.000	105.000	7.563
	5.000	0.990	10.000	1.510	105.000	107.237	3.389
	5.000	0.985	15.000	1.515			
	5.000	0.975	20.000	1.525			**160.194**
	5.000	0.955	25.000	1.545			
	5.000	0.935	30.000	1.565			
	5.000	0.990	35.000	1.510			
	5.000	1.040	40.000	1.460			
	5.000	1.010	45.000	1.490			
	5.000	0.980	50.000	1.520			
	5.000	1.095	55.000	1.405			
	5.000	1.205	60.000	1.295			
	5.000	1.030	65.000	1.470			
	5.000	0.850	70.000	1.650			
	5.000	0.955	75.000	1.545			
	5.000	1.055	80.000	1.445			
	5.000	1.035	85.000	1.465			
	5.000	1.015	90.000	1.485			
	5.000	1.000	95.000	1.500			
	5.000	0.990	100.000	1.510			
	5.000	0.985	105.000	1.515			
	2.237	0.985	107.237	1.515			
	0.000	1.010	0.000	1.490	0.000	100.000	156.450
40 L	5.000	1.005	5.000	1.495	100.000	105.000	7.650
	5.000	0.995	10.000	1.505	105.000	107.051	3.179
	5.000	0.980	15.000	1.520			
	5.000	0.965	20.000	1.535			**167.279**
	5.000	0.940	25.000	1.560			
	5.000	0.910	30.000	1.590			
	5.000	0.970	35.000	1.530			
	5.000	1.025	40.000	1.475			
	5.000	0.890	45.000	1.610			
	5.000	0.755	50.000	1.745			
	5.000	0.920	55.000	1.580			
	5.000	1.080	60.000	1.420			
	5.000	0.835	65.000	1.665			
	5.000	0.590	70.000	1.910			
	5.000	0.835	75.000	1.665			
	5.000	1.075	80.000	1.425			
	5.000	1.015	85.000	1.485			
	5.000	0.950	90.000	1.550			
	5.000	0.970	95.000	1.530			

	5.000	0.990	100.000	1.510			
	5.000	0.950	105.000	1.550			
	2.051	0.950	107.051	1.550			
	0.000	1.060	0.000	1.440	0.000	100.000	156.900
45 L	5.000	1.020	5.000	1.480	100.000	105.000	7.788
	5.000	0.980	10.000	1.520	105.000	106.865	2.919
	5.000	0.985	15.000	1.515			
	5.000	0.990	20.000	1.510			**167.607**
	5.000	0.955	25.000	1.545			
	5.000	0.915	30.000	1.585			
	5.000	0.970	35.000	1.530			
	5.000	1.020	40.000	1.480			
	5.000	0.920	45.000	1.580			
	5.000	0.815	50.000	1.685			
	5.000	0.925	55.000	1.575			
	5.000	1.025	60.000	1.475			
	5.000	0.800	65.000	1.700			
	5.000	0.570	70.000	1.930			
	5.000	0.800	75.000	1.700			
	5.000	1.030	80.000	1.470			
	5.000	0.990	85.000	1.510			
	5.000	0.950	90.000	1.550			
	5.000	0.950	95.000	1.550			
	5.000	0.950	100.000	1.550			
	5.000	0.935	105.000	1.565			
	1.865	0.935	106.865	1.565			
	0.000	1.105	0.000	1.395	0.000	100.000	157.625
50 L	5.000	1.035	5.000	1.465	100.000	105.000	7.938
	5.000	0.960	10.000	1.540	105.000	106.679	2.661
	5.000	0.985	15.000	1.515			
	5.000	1.010	20.000	1.490			**168.224**
	5.000	0.965	25.000	1.535			
	5.000	0.920	30.000	1.580			
	5.000	0.965	35.000	1.535			
	5.000	1.010	40.000	1.490			
	5.000	0.945	45.000	1.555			
	5.000	0.875	50.000	1.625			
	5.000	0.925	55.000	1.575			
	5.000	0.970	60.000	1.530			
	5.000	0.760	65.000	1.740			
	5.000	0.550	70.000	1.950			
	5.000	0.765	75.000	1.735			
	5.000	0.980	80.000	1.520			
	5.000	0.965	85.000	1.535			
	5.000	0.950	90.000	1.550			
	5.000	0.930	95.000	1.570			
	5.000	0.910	100.000	1.590			
	5.000	0.915	105.000	1.585			
	1.679	0.915	106.679	1.585			

	0.000	1.070	0.000	1.430	0.000	100.000	157.083
55 L	5.000	1.025	5.000	1.475	100.000	105.000	7.900
	5.000	0.980	10.000	1.520	105.000	106.493	2.344
	5.000	0.985	15.000	1.515			
	5.000	0.985	20.000	1.515			**167.327**
	5.000	0.965	25.000	1.535			
	5.000	0.940	30.000	1.560			
	5.000	0.975	35.000	1.525			
	5.000	1.005	40.000	1.495			
	5.000	0.970	45.000	1.530			
	5.000	0.935	50.000	1.565			
	5.000	0.965	55.000	1.535			
	5.000	0.995	60.000	1.505			
	5.000	0.765	65.000	1.735			
	5.000	0.535	70.000	1.965			
	5.000	0.745	75.000	1.755			
	5.000	0.950	80.000	1.550			
	5.000	0.960	85.000	1.540			
	5.000	0.970	90.000	1.530			
	5.000	0.940	95.000	1.560			
	5.000	0.910	100.000	1.590			
	5.000	0.930	105.000	1.570			
	1.493	0.930	106.493	1.570			
	0.000	1.035	0.000	1.465	0.000	100.000	156.733
60 L	5.000	1.020	5.000	1.480	100.000	105.000	7.875
	5.000	1.000	10.000	1.500	105.000	106.307	2.032
	5.000	0.980	15.000	1.520			
	5.000	0.960	20.000	1.540			**166.640**
	5.000	0.960	25.000	1.540			
	5.000	0.955	30.000	1.545			
	5.000	0.980	35.000	1.520			
	5.000	1.000	40.000	1.500			
	5.000	0.995	45.000	1.505			
	5.000	0.990	50.000	1.510			
	5.000	1.005	55.000	1.495			
	5.000	1.020	60.000	1.480			
	5.000	0.770	65.000	1.730			
	5.000	0.520	70.000	1.980			
	5.000	0.720	75.000	1.780			
	5.000	0.920	80.000	1.580			
	5.000	0.955	85.000	1.545			
	5.000	0.985	90.000	1.515			
	5.000	0.945	95.000	1.555			
	5.000	0.905	100.000	1.595			
	5.000	0.945	105.000	1.555			
	1.307	0.945	106.307	1.555			
	0.000	1.015	0.000	1.485	0.000	100.000	155.175
65 L	5.000	0.995	5.000	1.505	100.000	105.000	7.850
	5.000	0.970	10.000	1.530	105.000	106.121	1.738
	5.000	0.975	15.000	1.525			
	5.000	0.980	20.000	1.520			**164.763**

	5.000	0.980	25.000	1.520			
	5.000	0.980	30.000	1.520			
	5.000	0.985	35.000	1.515			
	5.000	0.990	40.000	1.510			
	5.000	1.000	45.000	1.500			
	5.000	1.010	50.000	1.490			
	5.000	1.020	55.000	1.480			
	5.000	1.025	60.000	1.475			
	5.000	0.785	65.000	1.715			
	5.000	0.545	70.000	1.955			
	5.000	0.785	75.000	1.715			
	5.000	1.025	80.000	1.475			
	5.000	1.010	85.000	1.490			
	5.000	0.990	90.000	1.510			
	5.000	0.950	95.000	1.550			
	5.000	0.910	100.000	1.590			
	5.000	0.950	105.000	1.550			
	1.121	0.950	106.121	1.550			
	0.000	0.990	0.000	1.510	0.000	100.000	153.792
70 L	5.000	0.965	5.000	1.535	100.000	105.000	7.825
	5.000	0.940	10.000	1.560	105.000	105.935	1.445
	5.000	0.970	15.000	1.530			
	5.000	1.000	20.000	1.500			**163.062**
	5.000	1.000	25.000	1.500			
	5.000	1.000	30.000	1.500			
	5.000	0.990	35.000	1.510			
	5.000	0.980	40.000	1.520			
	5.000	1.005	45.000	1.495			
	5.000	1.025	50.000	1.475			
	5.000	1.030	55.000	1.470			
	5.000	1.030	60.000	1.470			
	5.000	0.800	65.000	1.700			
	5.000	0.565	70.000	1.935			
	5.000	0.850	75.000	1.650			
	5.000	1.130	80.000	1.370			
	5.000	1.060	85.000	1.440			
	5.000	0.990	90.000	1.510			
	5.000	0.955	95.000	1.545			
	5.000	0.915	100.000	1.585			
	5.000	0.955	105.000	1.545			
	0.935	0.955	105.935	1.545			
	0.000	1.005	0.000	1.495	0.000	100.000	152.742
75 L	5.000	0.985	5.000	1.515	100.000	105.000	7.800
	5.000	0.965	10.000	1.535	105.000	105.749	1.153
	5.000	0.980	15.000	1.520			
	5.000	0.995	20.000	1.505			**161.695**
	5.000	1.000	25.000	1.500			
	5.000	1.005	30.000	1.495			
	5.000	1.000	35.000	1.500			
	5.000	0.995	40.000	1.505			
	5.000	1.020	45.000	1.480			

	5.000	1.040	50.000	1.460			
	5.000	1.010	55.000	1.490			
	5.000	0.975	60.000	1.525			
	5.000	0.865	65.000	1.635			
	5.000	0.750	70.000	1.750			
	5.000	0.895	75.000	1.605			
	5.000	1.035	80.000	1.465			
	5.000	1.015	85.000	1.485			
	5.000	0.995	90.000	1.505			
	5.000	0.960	95.000	1.540			
	5.000	0.920	100.000	1.580			
	5.000	0.960	105.000	1.540			
	0.749	0.960	105.749	1.540			
	0.000	1.015	0.000	1.485	0.000	100.000	151.900
80 L	5.000	1.005	5.000	1.495	100.000	105.000	7.788
	5.000	0.990	10.000	1.510	105.000	105.563	0.867
	5.000	0.990	15.000	1.510			
	5.000	0.985	20.000	1.515			**160.555**
	5.000	0.995	25.000	1.505			
	5.000	1.005	30.000	1.495			
	5.000	1.010	35.000	1.490			
	5.000	1.010	40.000	1.490			
	5.000	1.035	45.000	1.465			
	5.000	1.055	50.000	1.445			
	5.000	0.990	55.000	1.510			
	5.000	0.920	60.000	1.580			
	5.000	0.925	65.000	1.575			
	5.000	0.930	70.000	1.570			
	5.000	0.935	75.000	1.565			
	5.000	0.940	80.000	1.560			
	5.000	0.970	85.000	1.530			
	5.000	0.995	90.000	1.505			
	5.000	0.960	95.000	1.540			
	5.000	0.925	100.000	1.575			
	5.000	0.960	105.000	1.540			
	0.563	0.960	105.563	1.540			
	0.000	1.000	0.000	1.500	0.000	100.000	155.050
85 L	5.000	0.995	5.000	1.505	100.000	105.000	7.763
	5.000	0.990	10.000	1.510	105.000	105.378	0.580
	5.000	0.985	15.000	1.515			
	5.000	0.975	20.000	1.525			**163.393**
	5.000	0.985	25.000	1.515			
	5.000	0.995	30.000	1.505			
	5.000	0.995	35.000	1.505			
	5.000	0.985	40.000	1.515			
	5.000	1.005	45.000	1.495			
	5.000	1.025	50.000	1.475			
	5.000	1.050	55.000	1.450			
	5.000	1.075	60.000	1.425			
	5.000	0.910	65.000	1.590			
	5.000	0.740	70.000	1.760			

	5.000	0.730	75.000	1.770			
	5.000	0.720	80.000	1.780			
	5.000	0.870	85.000	1.630			
	5.000	1.015	90.000	1.485			
	5.000	0.975	95.000	1.525			
	5.000	0.930	100.000	1.570			
	5.000	0.965	105.000	1.535			
	0.378	0.965	105.378	1.535			
	0.000	0.985	0.000	1.515	0.000	100.000	158.333
90 L	5.000	0.990	5.000	1.510	100.000	105.000	7.750
	5.000	0.990	10.000	1.510	105.000	105.192	0.295
	5.000	0.980	15.000	1.520			
	5.000	0.965	20.000	1.535			**166.378**
	5.000	0.975	25.000	1.525			
	5.000	0.985	30.000	1.515			
	5.000	0.975	35.000	1.525			
	5.000	0.960	40.000	1.540			
	5.000	0.975	45.000	1.525			
	5.000	0.990	50.000	1.510			
	5.000	1.110	55.000	1.390			
	5.000	1.230	60.000	1.270			
	5.000	0.890	65.000	1.610			
	5.000	0.550	70.000	1.950			
	5.000	0.525	75.000	1.975			
	5.000	0.500	80.000	2.000			
	5.000	0.765	85.000	1.735			
	5.000	1.030	90.000	1.470			
	5.000	0.985	95.000	1.515			
	5.000	0.935	100.000	1.565			
	5.000	0.965	105.000	1.535			
	0.192	0.965	105.192	1.535			
	0.000	1.005	0.000	1.495	0.000	100.000	156.142
95 L	5.000	1.000	5.000	1.500	100.000	105.000	7.725
	5.000	0.995	10.000	1.505	105.000	105.006	0.009
	5.000	0.990	15.000	1.510			
	5.000	0.980	20.000	1.520			**163.876**
	5.000	0.980	25.000	1.520			
	5.000	0.985	30.000	1.515			
	5.000	0.990	35.000	1.510			
	5.000	0.990	40.000	1.510			
	5.000	1.000	45.000	1.500			
	5.000	1.005	50.000	1.495			
	5.000	1.085	55.000	1.415			
	5.000	1.165	60.000	1.335			
	5.000	0.860	65.000	1.640			
	5.000	0.550	70.000	1.950			
	5.000	0.640	75.000	1.860			
	5.000	0.730	80.000	1.770			
	5.000	0.870	85.000	1.630			
	5.000	1.005	90.000	1.495			
	5.000	0.975	95.000	1.525			

	5.000	0.940	100.000	1.560			
	5.000	0.970	105.000	1.530			
	0.006	0.970	105.006	1.530			
	0.000	1.025	0.000	1.475	0.000	100.000	154.233
100 L	5.000	1.010	5.000	1.490	100.000	104.820	7.435
	5.000	0.995	10.000	1.505			
	5.000	0.995	15.000	1.505			
	5.000	0.990	20.000	1.510			**161.668**
	5.000	0.985	25.000	1.515			
	5.000	0.980	30.000	1.520			
	5.000	1.000	35.000	1.500			
	5.000	1.020	40.000	1.480			
	5.000	1.020	45.000	1.480			
	5.000	1.015	50.000	1.485			
	5.000	1.055	55.000	1.445			
	5.000	1.095	60.000	1.405			
	5.000	0.825	65.000	1.675			
	5.000	0.550	70.000	1.950			
	5.000	0.755	75.000	1.745			
	5.000	0.960	80.000	1.540			
	5.000	0.970	85.000	1.530			
	5.000	0.980	90.000	1.520			
	5.000	0.965	95.000	1.535			
	5.000	0.945	100.000	1.555			
	4.820	0.970	104.820	1.530			
	0.000	1.015	0.000	1.485	0.000	100.000	155.042
105 L	5.000	1.005	5.000	1.495	100.000	104.634	7.125
	5.000	0.995	10.000	1.505			
	5.000	0.990	15.000	1.510			
	5.000	0.985	20.000	1.515			**162.167**
	5.000	0.990	25.000	1.510			
	5.000	0.995	30.000	1.505			
	5.000	0.985	35.000	1.515			
	5.000	0.970	40.000	1.530			
	5.000	1.000	45.000	1.500			
	5.000	1.025	50.000	1.475			
	5.000	0.935	55.000	1.565			
	5.000	0.840	60.000	1.660			
	5.000	0.790	65.000	1.710			
	5.000	0.735	70.000	1.765			
	5.000	0.850	75.000	1.650			
	5.000	0.965	80.000	1.535			
	5.000	0.980	85.000	1.520			
	5.000	0.995	90.000	1.505			
	5.000	0.975	95.000	1.525			
	5.000	0.950	100.000	1.550			
	4.634	0.975	104.634	1.525			
	0.000	1.005	0.000	1.495	0.000	100.000	156.100
110 L	5.000	1.000	5.000	1.500	100.000	104.448	6.817
	5.000	0.990	10.000	1.510			

INSTITUTE OF REMOTE SENSING
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	5.000	0.985	15.000	1.515			
	5.000	0.975	20.000	1.525			**162.917**
	5.000	0.995	25.000	1.505			
	5.000	1.010	30.000	1.490			
	5.000	0.965	35.000	1.535			
	5.000	0.920	40.000	1.580			
	5.000	0.975	45.000	1.525			
	5.000	1.030	50.000	1.470			
	5.000	0.810	55.000	1.690			
	5.000	0.585	60.000	1.915			
	5.000	0.750	65.000	1.750			
	5.000	0.915	70.000	1.585			
	5.000	0.940	75.000	1.560			
	5.000	0.965	80.000	1.535			
	5.000	0.990	85.000	1.510			
	5.000	1.010	90.000	1.490			
	5.000	0.985	95.000	1.515			
	5.000	0.955	100.000	1.545			
	4.448	0.980	104.448	1.520			
	0.000	0.955	0.000	1.545	0.000	100.000	157.167
115 L	5.000	0.965	5.000	1.535	100.000	104.262	6.532
	5.000	0.970	10.000	1.530			
	5.000	0.970	15.000	1.530			
	5.000	0.965	20.000	1.535			**163.699**
	5.000	0.985	25.000	1.515			
	5.000	1.005	30.000	1.495			
	5.000	0.970	35.000	1.530			
	5.000	0.935	40.000	1.565			
	5.000	0.960	45.000	1.540			
	5.000	0.985	50.000	1.515			
	5.000	0.770	55.000	1.730			
	5.000	0.550	60.000	1.950			
	5.000	0.730	65.000	1.770			
	5.000	0.915	70.000	1.585			
	5.000	0.950	75.000	1.550			
	5.000	0.985	80.000	1.515			
	5.000	1.000	85.000	1.500			
	5.000	1.015	90.000	1.485			
	5.000	0.985	95.000	1.515			
	5.000	0.955	100.000	1.545			
	4.262	0.980	104.262	1.520			
	0.000	0.905	0.000	1.595	0.000	100.000	158.533
120 L	5.000	0.925	5.000	1.575	100.000	104.076	6.246
	5.000	0.945	10.000	1.555			
	5.000	0.950	15.000	1.550			
	5.000	0.950	20.000	1.550			**164.779**
	5.000	0.975	25.000	1.525			
	5.000	1.000	30.000	1.500			
	5.000	0.975	35.000	1.525			
	5.000	0.945	40.000	1.555			
	5.000	0.940	45.000	1.560			

	5.000	0.935	50.000	1.565			
	5.000	0.725	55.000	1.775			
	5.000	0.510	60.000	1.990			
	5.000	0.710	65.000	1.790			
	5.000	0.910	70.000	1.590			
	5.000	0.955	75.000	1.545			
	5.000	1.000	80.000	1.500			
	5.000	1.010	85.000	1.490			
	5.000	1.015	90.000	1.485			
	5.000	0.985	95.000	1.515			
	5.000	0.955	100.000	1.545			
	4.076	0.980	104.076	1.520			
	0.000	0.895	0.000	1.605	0.000	100.000	159.342
125 L	5.000	0.925	5.000	1.575	100.000	103.890	5.942
	5.000	0.955	10.000	1.545			
	5.000	0.965	15.000	1.535			
	5.000	0.965	20.000	1.535			**165.284**
	5.000	0.975	25.000	1.525			
	5.000	0.985	30.000	1.515			
	5.000	0.970	35.000	1.530			
	5.000	0.950	40.000	1.550			
	5.000	0.910	45.000	1.590			
	5.000	0.870	50.000	1.630			
	5.000	0.710	55.000	1.790			
	5.000	0.545	60.000	1.955			
	5.000	0.720	65.000	1.780			
	5.000	0.895	70.000	1.605			
	5.000	0.920	75.000	1.580			
	5.000	0.945	80.000	1.555			
	5.000	0.985	85.000	1.515			
	5.000	1.020	90.000	1.480			
	5.000	0.990	95.000	1.510			
	5.000	0.960	100.000	1.540			
	3.890	0.985	103.890	1.515			
	0.000	0.880	0.000	1.620	0.000	100.000	160.392
130 L	5.000	0.925	5.000	1.575	100.000	103.704	5.639
	5.000	0.965	10.000	1.535			
	5.000	0.975	15.000	1.525			
	5.000	0.980	20.000	1.520			**166.031**
	5.000	0.975	25.000	1.525			
	5.000	0.970	30.000	1.530			
	5.000	0.960	35.000	1.540			
	5.000	0.950	40.000	1.550			
	5.000	0.875	45.000	1.625			
	5.000	0.800	50.000	1.700			
	5.000	0.690	55.000	1.810			
	5.000	0.575	60.000	1.925			
	5.000	0.730	65.000	1.770			
	5.000	0.880	70.000	1.620			
	5.000	0.885	75.000	1.615			
	5.000	0.890	80.000	1.610			

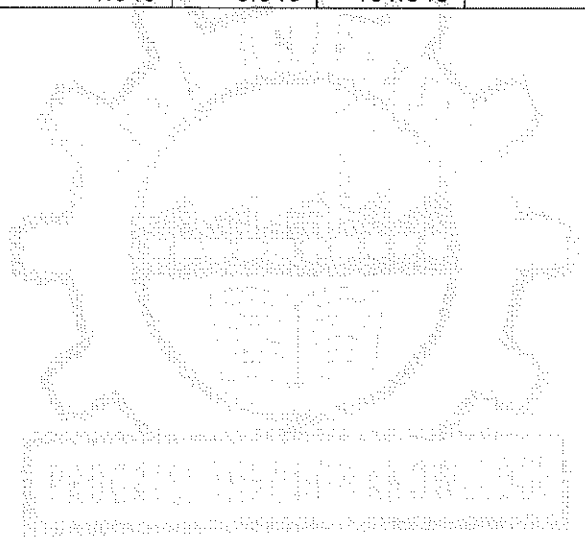
	5.000	0.955	85.000	1.545			
	5.000	1.020	90.000	1.480			
	5.000	0.995	95.000	1.505			
	5.000	0.965	100.000	1.535			
	3.704	0.990	103.704	1.510			
	0.000	0.875	0.000	1.625	0.000	100.000	158.208
135 L	5.000	0.910	5.000	1.590	100.000	103.519	5.340
	5.000	0.945	10.000	1.555			
	5.000	0.965	15.000	1.535			
	5.000	0.980	20.000	1.520			**163.548**
	5.000	0.980	25.000	1.520			
	5.000	0.980	30.000	1.520			
	5.000	0.945	35.000	1.555			
	5.000	0.905	40.000	1.595			
	5.000	0.835	45.000	1.665			
	5.000	0.760	50.000	1.740			
	5.000	0.760	55.000	1.740			
	5.000	0.755	60.000	1.745			
	5.000	0.850	65.000	1.650			
	5.000	0.945	70.000	1.555			
	5.000	0.950	75.000	1.550			
	5.000	0.955	80.000	1.545			
	5.000	0.990	85.000	1.510			
	5.000	1.020	90.000	1.480			
	5.000	1.000	95.000	1.500			
	5.000	0.970	100.000	1.530			
	3.519	0.995	103.519	1.505			
	0.000	0.865	0.000	1.635	0.000	100.000	156.333
140 L	5.000	0.895	5.000	1.605	100.000	103.333	5.083
	5.000	0.920	10.000	1.580			
	5.000	0.950	15.000	1.550			
	5.000	0.980	20.000	1.520			**161.416**
	5.000	0.985	25.000	1.515			
	5.000	0.990	30.000	1.510			
	5.000	0.925	35.000	1.575			
	5.000	0.860	40.000	1.640			
	5.000	0.790	45.000	1.710			
	5.000	0.720	50.000	1.780			
	5.000	0.825	55.000	1.675			
	5.000	0.930	60.000	1.570			
	5.000	0.970	65.000	1.530			
	5.000	1.005	70.000	1.495			
	5.000	1.010	75.000	1.490			
	5.000	1.015	80.000	1.485			
	5.000	1.020	85.000	1.480			
	5.000	1.020	90.000	1.480			
	5.000	1.000	95.000	1.500			
	5.000	0.975	100.000	1.525			
	3.333	0.975	103.333	1.525			

	0.000	0.835	0.000	1.665	0.000	100.000	154.092
145 L	5.000	0.885	5.000	1.615	100.000	103.147	4.783
	5.000	0.935	10.000	1.565			
	5.000	0.960	15.000	1.540			
	5.000	0.985	20.000	1.515			**158.875**
	5.000	0.985	25.000	1.515			
	5.000	0.985	30.000	1.515			
	5.000	0.945	35.000	1.555			
	5.000	0.900	40.000	1.600			
	5.000	0.880	45.000	1.620			
	5.000	0.855	50.000	1.645			
	5.000	0.905	55.000	1.595			
	5.000	0.955	60.000	1.545			
	5.000	0.980	65.000	1.520			
	5.000	1.000	70.000	1.500			
	5.000	1.020	75.000	1.480			
	5.000	1.035	80.000	1.465			
	5.000	1.030	85.000	1.470			
	5.000	1.025	90.000	1.475			
	5.000	1.005	95.000	1.495			
	5.000	0.980	100.000	1.520			
	3.147	0.980	103.147	1.520			
	0.000	0.805	0.000	1.695	0.000	100.000	152.083
150 L	5.000	0.875	5.000	1.625	100.000	102.961	4.486
	5.000	0.945	10.000	1.555			
	5.000	0.970	15.000	1.530			
	5.000	0.990	20.000	1.510			**156.569**
	5.000	0.985	25.000	1.515			
	5.000	0.975	30.000	1.525			
	5.000	0.960	35.000	1.540			
	5.000	0.940	40.000	1.560			
	5.000	0.965	45.000	1.535			
	5.000	0.990	50.000	1.510			
	5.000	0.985	55.000	1.515			
	5.000	0.980	60.000	1.520			
	5.000	0.985	65.000	1.515			
	5.000	0.990	70.000	1.510			
	5.000	1.025	75.000	1.475			
	5.000	1.055	80.000	1.445			
	5.000	1.040	85.000	1.460			
	5.000	1.025	90.000	1.475			
	5.000	1.005	95.000	1.495			
	5.000	0.985	100.000	1.515			
	2.961	0.985	102.961	1.515			
	0.000	0.930	0.000	1.570	0.000	100.000	151.058
155 L	5.000	0.950	5.000	1.550	100.000	102.775	4.287
	5.000	0.965	10.000	1.535			
	5.000	0.970	15.000	1.530			
	5.000	0.975	20.000	1.525			**155.345**
	5.000	0.975	25.000	1.525			
	5.000	0.975	30.000	1.525			

	5.000	0.955	35.000	1.545			
	5.000	0.935	40.000	1.565			
	5.000	0.965	45.000	1.535			
	5.000	0.995	50.000	1.505			
	5.000	1.030	55.000	1.470			
	5.000	1.060	60.000	1.440			
	5.000	1.025	65.000	1.475			
	5.000	0.990	70.000	1.510			
	5.000	1.025	75.000	1.475			
	5.000	1.060	80.000	1.440			
	5.000	1.025	85.000	1.475			
	5.000	0.995	90.000	1.505			
	5.000	0.975	95.000	1.525			
	5.000	0.955	100.000	1.545			
	2.775	0.955	102.775	1.545			
	0.000	1.050	0.000	1.450	0.000	100.000	150.225
160 L	5.000	1.015	5.000	1.485	100.000	102.589	4.078
	5.000	0.980	10.000	1.520			
	5.000	0.970	15.000	1.530			
	5.000	0.960	20.000	1.540			**154.303**
	5.000	0.965	25.000	1.535			
	5.000	0.970	30.000	1.530			
	5.000	0.950	35.000	1.550			
	5.000	0.930	40.000	1.570			
	5.000	0.965	45.000	1.535			
	5.000	0.995	50.000	1.505			
	5.000	1.070	55.000	1.430			
	5.000	1.140	60.000	1.360			
	5.000	1.065	65.000	1.435			
	5.000	0.990	70.000	1.510			
	5.000	1.025	75.000	1.475			
	5.000	1.060	80.000	1.440			
	5.000	1.010	85.000	1.490			
	5.000	0.960	90.000	1.540			
	5.000	0.945	95.000	1.555			
	5.000	0.925	100.000	1.575			
	2.589	0.925	102.589	1.575			
	0.000	1.030	0.000	1.470	0.000	100.000	150.967
165 L	5.000	1.010	5.000	1.490	100.000	102.403	3.773
	5.000	0.985	10.000	1.515			
	5.000	0.975	15.000	1.525			
	5.000	0.960	20.000	1.540			**154.740**
	5.000	0.955	25.000	1.545			
	5.000	0.945	30.000	1.555			
	5.000	0.945	35.000	1.555			
	5.000	0.945	40.000	1.555			
	5.000	0.985	45.000	1.515			
	5.000	1.020	50.000	1.480			
	5.000	1.035	55.000	1.465			
	5.000	1.050	60.000	1.450			
	5.000	1.030	65.000	1.470			

	5.000	1.000	70.000	1.500			
	5.000	1.020	75.000	1.480			
	5.000	1.040	80.000	1.460			
	5.000	1.005	85.000	1.495			
	5.000	0.965	90.000	1.535			
	5.000	0.950	95.000	1.550			
	5.000	0.930	100.000	1.570			
	2.403	0.930	102.403	1.570			
	0.000	1.005	0.000	1.495	0.000	100.000	152.017
170 L	5.000	1.000	5.000	1.500	100.000	102.217	3.470
	5.000	0.990	10.000	1.510			
	5.000	0.975	15.000	1.525			
	5.000	0.960	20.000	1.540			**155.487**
	5.000	0.940	25.000	1.560			
	5.000	0.920	30.000	1.580			
	5.000	0.940	35.000	1.560			
	5.000	0.955	40.000	1.545			
	5.000	1.000	45.000	1.500			
	5.000	1.040	50.000	1.460			
	5.000	1.000	55.000	1.500			
	5.000	0.955	60.000	1.545			
	5.000	0.990	65.000	1.510			
	5.000	1.010	70.000	1.490			
	5.000	1.015	75.000	1.485			
	5.000	1.020	80.000	1.480			
	5.000	0.995	85.000	1.505			
	5.000	0.965	90.000	1.535			
	5.000	0.950	95.000	1.550			
	5.000	0.935	100.000	1.565			
	2.217	0.935	102.217	1.565			
	0.000	1.030	0.000	1.470	0.000	100.000	155.100
175 L	5.000	0.990	5.000	1.510	100.000	102.031	3.168
	5.000	0.945	10.000	1.555			
	5.000	0.955	15.000	1.545			
	5.000	0.965	20.000	1.535			**158.268**
	5.000	0.925	25.000	1.575			
	5.000	0.885	30.000	1.615			
	5.000	0.845	35.000	1.655			
	5.000	0.795	40.000	1.705			
	5.000	0.905	45.000	1.595			
	5.000	1.005	50.000	1.495			
	5.000	0.960	55.000	1.540			
	5.000	0.910	60.000	1.590			
	5.000	0.970	65.000	1.530			
	5.000	1.020	70.000	1.480			
	5.000	1.010	75.000	1.490			
	5.000	0.995	80.000	1.505			
	5.000	0.985	85.000	1.515			
	5.000	0.965	90.000	1.535			
	5.000	0.955	95.000	1.545			
	5.000	0.940	100.000	1.560			

	2.031	0.940	102.031	1.560			
	0.000	1.050	0.000	1.450	0.000	100.000	158.492
180 L	5.000	0.975	5.000	1.525	100.000	101.845	2.869
	5.000	0.895	10.000	1.605			
	5.000	0.935	15.000	1.565			
	5.000	0.970	20.000	1.530			**161.361**
	5.000	0.910	25.000	1.590			
	5.000	0.850	30.000	1.650			
	5.000	0.745	35.000	1.755			
	5.000	0.635	40.000	1.865			
	5.000	0.805	45.000	1.695			
	5.000	0.970	50.000	1.530			
	5.000	0.915	55.000	1.585			
	5.000	0.860	60.000	1.640			
	5.000	0.945	65.000	1.555			
	5.000	1.030	70.000	1.470			
	5.000	1.000	75.000	1.500			
	5.000	0.970	80.000	1.530			
	5.000	0.970	85.000	1.530			
	5.000	0.965	90.000	1.535			
	5.000	0.955	95.000	1.545			
	5.000	0.945	100.000	1.555			
	1.845	0.945	101.845	1.555			



COMPUTATION OF FILLING QUANTITY FOR PART 2 OF MIG - PART				
Chainage (m)	**C/S Area (m^2)**			
-10.000	159.743	-10.000	180 L	**30693.083**
-5.000	159.440			
0 L	159.490			
5 L	161.477			
10 L	163.752			
15 L	160.992			
20 L	158.491			
25 L	155.781			
30 L	153.390			
35 L	160.194			
40 L	167.279			
45 L	167.607			
50 L	168.224			
55 L	167.327			
60 L	166.640			
65 L	164.763			
70 L	163.062			
75 L	161.695			
80 L	160.555			
85 L	163.393			
90 L	166.378			
95 L	163.876			
100 L	161.668			
105 L	162.167			
110 L	162.917			
115 L	163.699			
120 L	164.779			
125 L	165.284			
130 L	166.031			
135 L	163.548			
140 L	161.416			
145 L	158.875			
150 L	156.569			
155 L	155.345			
160 L	154.303			
165 L	154.740			
170 L	155.487			
175 L	158.268			
180 L	161.361			

COMPUTATION OF CROSS SECTIONAL AREA FOR PART 3 OF MIG - PART

Chainage (m)	Interval (m)	RL (m)	C.S (m)	Fill Depth (m)	Cross Sectional Area (m^2)		
	0.000	1.095	0.000	1.405	0.000	70.000	92.400
5 L	5.000	1.115	5.000	1.385	70.000	75.000	7.163
	5.000	1.135	10.000	1.365	75.000	78.130	4.914
	5.000	1.190	15.000	1.310			**104.477**
	5.000	1.250	20.000	1.250			
	5.000	1.150	25.000	1.350			
	5.000	1.050	30.000	1.450			
	5.000	1.120	35.000	1.380			
	5.000	1.190	40.000	1.310			
	5.000	1.255	45.000	1.245			
	5.000	1.320	50.000	1.180			
	5.000	1.260	55.000	1.240			
	5.000	1.200	60.000	1.300			
	5.000	1.170	65.000	1.330			
	5.000	1.135	70.000	1.365			
	5.000	1.000	75.000	1.500			
	3.130	0.860	78.130	1.640			
	0.000	0.725	0.000	1.775	0.000	70.000	99.217
10 L	5.000	0.880	5.000	1.620	70.000	75.000	7.138
	5.000	1.035	10.000	1.465	75.000	78.158	4.524
	5.000	1.045	15.000	1.455			**110.879**
	5.000	1.050	20.000	1.450			
	5.000	1.060	25.000	1.440			
	5.000	1.070	30.000	1.430			
	5.000	1.125	35.000	1.375			
	5.000	1.180	40.000	1.320			
	5.000	1.240	45.000	1.260			
	5.000	1.295	50.000	1.205			
	5.000	1.170	55.000	1.330			
	5.000	1.045	60.000	1.455			
	5.000	1.060	65.000	1.440			
	5.000	1.075	70.000	1.425			
	5.000	1.070	75.000	1.430			
	3.158	1.065	78.158	1.435			
	0.000	0.970	0.000	1.530	0.000	70.000	99.342
15 L	5.000	1.015	5.000	1.485	70.000	75.000	7.025
	5.000	1.060	10.000	1.440	75.000	78.187	4.685
	5.000	1.095	15.000	1.405			**111.052**
	5.000	1.125	20.000	1.375			
	5.000	1.080	25.000	1.420			
	5.000	1.030	30.000	1.470			
	5.000	1.060	35.000	1.440			
	5.000	1.085	40.000	1.415			
	5.000	1.120	45.000	1.380			
	5.000	1.155	50.000	1.345			
	5.000	1.105	55.000	1.395			
	5.000	1.070	60.000	1.430			

	5.000	1.090	65.000	1.410			
	5.000	1.115	70.000	1.385			
	5.000	1.075	75.000	1.425			
	3.187	0.985	78.187	1.515			
	0.000	1.210	0.000	1.290	0.000	70.000	99.742
20 L	5.000	1.150	5.000	1.350	70.000	75.000	6.900
	5.000	1.085	10.000	1.415	75.000	78.216	4.728
	5.000	1.140	15.000	1.360			**111.370**
	5.000	1.195	20.000	1.305			
	5.000	1.095	25.000	1.405			
	5.000	0.990	30.000	1.510			
	5.000	0.990	35.000	1.510			
	5.000	0.985	40.000	1.515			
	5.000	1.000	45.000	1.500			
	5.000	1.015	50.000	1.485			
	5.000	1.040	55.000	1.460			
	5.000	1.060	60.000	1.440			
	5.000	1.115	65.000	1.385			
	5.000	1.165	70.000	1.335			
	5.000	1.075	75.000	1.425			
	3.216	0.985	78.216	1.515			
	0.000	1.175	0.000	1.325	0.000	70.000	102.558
25 L	5.000	1.110	5.000	1.390	70.000	75.000	7.250
	5.000	1.045	10.000	1.455	75.000	78.245	4.843
	5.000	1.070	15.000	1.430			**114.651**
	5.000	1.100	20.000	1.400			
	5.000	1.070	25.000	1.430			
	5.000	1.035	30.000	1.465			
	5.000	1.000	35.000	1.500			
	5.000	0.965	40.000	1.535			
	5.000	0.970	45.000	1.530			
	5.000	0.975	50.000	1.525			
	5.000	0.990	55.000	1.510			
	5.000	1.000	60.000	1.500			
	5.000	1.035	65.000	1.465			
	5.000	1.070	70.000	1.430			
	5.000	1.030	75.000	1.470			
	3.245	0.985	78.245	1.515			
	0.000	1.135	0.000	1.365	0.000	70.000	105.533
30 L	5.000	1.070	5.000	1.430	70.000	75.000	7.613
	5.000	1.000	10.000	1.500	75.000	78.274	4.968
	5.000	1.000	15.000	1.500			**118.114**
	5.000	1.000	20.000	1.500			
	5.000	1.040	25.000	1.460			
	5.000	1.075	30.000	1.425			
	5.000	1.010	35.000	1.490			
	5.000	0.940	40.000	1.560			
	5.000	0.940	45.000	1.560			
	5.000	0.935	50.000	1.565			
	5.000	0.935	55.000	1.565			

	5.000	0.935	60.000	1.565			
	5.000	0.955	65.000	1.545			
	5.000	0.975	70.000	1.525			
	5.000	0.980	75.000	1.520			
	3.274	0.985	78.274	1.515			
	0.000	1.175	0.000	1.325	0.000	70.000	101.525
35 L	5.000	1.120	5.000	1.380	70.000	75.000	7.400
	5.000	1.070	10.000	1.430	75.000	78.303	4.822
	5.000	1.055	15.000	1.445			**113.747**
	5.000	1.035	20.000	1.465			
	5.000	1.055	25.000	1.445			
	5.000	1.070	30.000	1.430			
	5.000	1.075	35.000	1.425			
	5.000	1.080	40.000	1.420			
	5.000	1.040	45.000	1.460			
	5.000	0.995	50.000	1.505			
	5.000	1.000	55.000	1.500			
	5.000	1.000	60.000	1.500			
	5.000	1.005	65.000	1.495			
	5.000	1.010	70.000	1.490			
	5.000	1.030	75.000	1.470			
	3.303	1.050	78.303	1.450			
	0.000	1.210	0.000	1.290	0.000	70.000	97.675
40 L	5.000	1.175	5.000	1.325	70.000	75.000	7.188
	5.000	1.140	10.000	1.360	75.000	78.332	4.673
	5.000	1.105	15.000	1.395			**109.536**
	5.000	1.065	20.000	1.435			
	5.000	1.065	25.000	1.435			
	5.000	1.060	30.000	1.440			
	5.000	1.140	35.000	1.360			
	5.000	1.220	40.000	1.280			
	5.000	1.135	45.000	1.365			
	5.000	1.050	50.000	1.450			
	5.000	1.060	55.000	1.440			
	5.000	1.065	60.000	1.435			
	5.000	1.055	65.000	1.445			
	5.000	1.045	70.000	1.455			
	5.000	1.080	75.000	1.420			
	3.332	1.115	78.332	1.385			
	0.000	1.260	0.000	1.240	0.000	70.000	98.233
45 L	5.000	1.205	5.000	1.295	70.000	75.000	7.163
	5.000	1.155	10.000	1.345	75.000	78.361	4.831
	5.000	1.115	15.000	1.385			**110.227**
	5.000	1.075	20.000	1.425			
	5.000	1.060	25.000	1.440			
	5.000	1.045	30.000	1.455			
	5.000	1.115	35.000	1.385			
	5.000	1.180	40.000	1.320			
	5.000	1.105	45.000	1.395			
	5.000	1.025	50.000	1.475			

INSTITUTE OF REMOTE SENSING
ANNA UNIVERSITY, CHENNAI 600025

	5.000	1.030	55.000	1.470			
	5.000	1.025	60.000	1.475			
	5.000	1.050	65.000	1.450			
	5.000	1.070	70.000	1.430			
	5.000	1.065	75.000	1.435			
	3.361	1.060	78.361	1.440			
	0.000	1.305	0.000	1.195	0.000	70.000	98.983
50 L	5.000	1.235	5.000	1.265	70.000	75.000	7.138
	5.000	1.165	10.000	1.335	75.000	78.390	4.992
	5.000	1.125	15.000	1.375			**111.113**
	5.000	1.080	20.000	1.420			
	5.000	1.055	25.000	1.445			
	5.000	1.030	30.000	1.470			
	5.000	1.085	35.000	1.415			
	5.000	1.135	40.000	1.365			
	5.000	1.070	45.000	1.430			
	5.000	1.000	50.000	1.500			
	5.000	0.995	55.000	1.505			
	5.000	0.985	60.000	1.515			
	5.000	1.040	65.000	1.460			
	5.000	1.095	70.000	1.405			
	5.000	1.050	75.000	1.450			
	3.390	1.005	78.390	1.495			
	0.000	1.375	0.000	1.125	0.000	80.000	112.275
55 L	5.000	1.265	5.000	1.235			
	5.000	1.155	10.000	1.345			
	5.000	1.125	15.000	1.375			**112.275**
	5.000	1.095	20.000	1.405			
	5.000	1.085	25.000	1.415			
	5.000	1.075	30.000	1.425			
	5.000	1.090	35.000	1.410			
	5.000	1.105	40.000	1.395			
	5.000	1.070	45.000	1.430			
	5.000	1.035	50.000	1.465			
	5.000	1.035	55.000	1.465			
	5.000	1.025	60.000	1.475			
	5.000	1.060	65.000	1.440			
	5.000	1.090	70.000	1.410			
	5.000	1.045	75.000	1.455			
	5.000	1.000	80.000	1.500			
	0.000	1.440	0.000	1.060	0.000	80.000	111.275
60 L	5.000	1.290	5.000	1.210			
	5.000	1.140	10.000	1.360			
	5.000	1.125	15.000	1.375			**111.275**
	5.000	1.105	20.000	1.395			
	5.000	1.110	25.000	1.390			
	5.000	1.115	30.000	1.385			
	5.000	1.095	35.000	1.405			
	5.000	1.070	40.000	1.430			
	5.000	1.070	45.000	1.430			

	5.000	1.070	50.000	1.430			
	5.000	1.070	55.000	1.430			
	5.000	1.065	60.000	1.435			
	5.000	1.075	65.000	1.425			
	5.000	1.085	70.000	1.415			
	5.000	1.040	75.000	1.460			
	5.000	0.995	80.000	1.505			
	0.000	1.280	0.000	1.220	0.000	80.000	113.075
65 L	5.000	1.220	5.000	1.280			
	5.000	1.165	10.000	1.335			
	5.000	1.130	15.000	1.370			**113.075**
	5.000	1.085	20.000	1.415			
	5.000	1.090	25.000	1.410			
	5.000	1.095	30.000	1.405			
	5.000	1.070	35.000	1.430			
	5.000	1.040	40.000	1.460			
	5.000	1.035	45.000	1.465			
	5.000	1.035	50.000	1.465			
	5.000	1.040	55.000	1.460			
	5.000	1.040	60.000	1.460			
	5.000	1.055	65.000	1.445			
	5.000	1.070	70.000	1.430			
	5.000	1.055	75.000	1.445			
	5.000	1.035	80.000	1.465			
	0.000	1.115	0.000	1.385	0.000	80.000	115.017
70 L	5.000	1.155	5.000	1.345			
	5.000	1.190	10.000	1.310			
	5.000	1.130	15.000	1.370			**115.017**
	5.000	1.065	20.000	1.435			
	5.000	1.070	25.000	1.430			
	5.000	1.075	30.000	1.425			
	5.000	1.040	35.000	1.460			
	5.000	1.005	40.000	1.495			
	5.000	1.000	45.000	1.500			
	5.000	0.995	50.000	1.505			
	5.000	1.005	55.000	1.495			
	5.000	1.015	60.000	1.485			
	5.000	1.035	65.000	1.465			
	5.000	1.055	70.000	1.445			
	5.000	1.065	75.000	1.435			
	5.000	1.075	80.000	1.425			
	0.000	1.100	0.000	1.400	0.000	80.000	115.158
75 L	5.000	1.125	5.000	1.375			
	5.000	1.145	10.000	1.355			
	5.000	1.130	15.000	1.370			**115.158**
	5.000	1.115	20.000	1.385			
	5.000	1.085	25.000	1.415			
	5.000	1.055	30.000	1.445			
	5.000	1.010	35.000	1.490			
	5.000	0.965	40.000	1.535			

	5.000	1.000	45.000	1.500			
	5.000	1.035	50.000	1.465			
	5.000	1.015	55.000	1.485			
	5.000	0.990	60.000	1.510			
	5.000	1.035	65.000	1.465			
	5.000	1.085	70.000	1.415			
	5.000	1.085	75.000	1.415			
	5.000	1.085	80.000	1.415			
	0.000	1.085	0.000	1.415	0.000	80.000	115.433
80 L	5.000	1.090	5.000	1.410			
	5.000	1.095	10.000	1.405			
	5.000	1.130	15.000	1.370			**115.433**
	5.000	1.160	20.000	1.340			
	5.000	1.100	25.000	1.400			
	5.000	1.035	30.000	1.465			
	5.000	0.980	35.000	1.520			
	5.000	0.925	40.000	1.575			
	5.000	1.000	45.000	1.500			
	5.000	1.075	50.000	1.425			
	5.000	1.020	55.000	1.480			
	5.000	0.960	60.000	1.540			
	5.000	1.035	65.000	1.465			
	5.000	1.110	70.000	1.390			
	5.000	1.105	75.000	1.395			
	5.000	1.095	80.000	1.405			
	0.000	1.145	0.000	1.355	0.000	80.000	111.892
85 L	5.000	1.175	5.000	1.325			
	5.000	1.205	10.000	1.295			
	5.000	1.210	15.000	1.290			**111.892**
	5.000	1.210	20.000	1.290			
	5.000	1.115	25.000	1.385			
	5.000	1.020	30.000	1.480			
	5.000	1.015	35.000	1.485			
	5.000	1.010	40.000	1.490			
	5.000	1.055	45.000	1.445			
	5.000	1.095	50.000	1.405			
	5.000	1.095	55.000	1.405			
	5.000	1.090	60.000	1.410			
	5.000	1.085	65.000	1.415			
	5.000	1.075	70.000	1.425			
	5.000	1.065	75.000	1.435			
	5.000	1.050	80.000	1.450			
	0.000	1.205	0.000	1.295	0.000	80.000	108.542
90 L	5.000	1.260	5.000	1.240			
	5.000	1.310	10.000	1.190			
	5.000	1.285	15.000	1.215			**108.542**
	5.000	1.255	20.000	1.245			
	5.000	1.130	25.000	1.370			
	5.000	1.005	30.000	1.495			
	5.000	1.050	35.000	1.450			

	5.000	1.095	40.000	1.405			
	5.000	1.105	45.000	1.395			
	5.000	1.115	50.000	1.385			
	5.000	1.170	55.000	1.330			
	5.000	1.220	60.000	1.280			
	5.000	1.130	65.000	1.370			
	5.000	1.035	70.000	1.465			
	5.000	1.020	75.000	1.480			
	5.000	1.000	80.000	1.500			
	0.000	1.140	0.000	1.360	0.000	80.000	112.142
95 L	5.000	1.180	5.000	1.320			
	5.000	1.220	10.000	1.280			
	5.000	1.205	15.000	1.295			**112.142**
	5.000	1.185	20.000	1.315			
	5.000	1.090	25.000	1.410			
	5.000	0.995	30.000	1.505			
	5.000	1.040	35.000	1.460			
	5.000	1.085	40.000	1.415			
	5.000	1.095	45.000	1.405			
	5.000	1.100	50.000	1.400			
	5.000	1.110	55.000	1.390			
	5.000	1.110	60.000	1.390			
	5.000	1.055	65.000	1.445			
	5.000	0.995	70.000	1.505			
	5.000	1.015	75.000	1.485			
	5.000	1.035	80.000	1.465			
	0.000	1.075	0.000	1.425	0.000	80.000	115.933
100 L	5.000	1.100	5.000	1.400			
	5.000	1.125	10.000	1.375			
	5.000	1.120	15.000	1.380			**115.933**
	5.000	1.110	20.000	1.390			
	5.000	1.045	25.000	1.455			
	5.000	0.980	30.000	1.520			
	5.000	1.030	35.000	1.470			
	5.000	1.075	40.000	1.425			
	5.000	1.080	45.000	1.420			
	5.000	1.085	50.000	1.415			
	5.000	1.045	55.000	1.455			
	5.000	1.000	60.000	1.500			
	5.000	0.980	65.000	1.520			
	5.000	0.955	70.000	1.545			
	5.000	1.010	75.000	1.490			
	5.000	1.065	80.000	1.435			
	0.000	0.990	0.000	1.510	0.000	80.000	117.100
105 L	5.000	1.075	5.000	1.425			
	5.000	1.160	10.000	1.340			
	5.000	1.115	15.000	1.385			**117.100**
	5.000	1.065	20.000	1.435			
	5.000	1.015	25.000	1.485			
	5.000	0.960	30.000	1.540			

	5.000	1.020	35.000	1.480			
	5.000	1.070	40.000	1.430			
	5.000	1.070	45.000	1.430			
	5.000	1.065	50.000	1.435			
	5.000	1.030	55.000	1.470			
	5.000	0.995	60.000	1.505			
	5.000	0.975	65.000	1.525			
	5.000	0.955	70.000	1.545			
	5.000	0.995	75.000	1.505			
	5.000	1.030	80.000	1.470			
	0.000	0.905	0.000	1.595	0.000	80.000	118.500
110 L	5.000	1.050	5.000	1.450			
	5.000	1.190	10.000	1.310			
	5.000	1.105	15.000	1.395			**118.500**
	5.000	1.015	20.000	1.485			
	5.000	0.980	25.000	1.520			
	5.000	0.940	30.000	1.560			
	5.000	1.005	35.000	1.495			
	5.000	1.065	40.000	1.435			
	5.000	1.055	45.000	1.445			
	5.000	1.040	50.000	1.460			
	5.000	1.015	55.000	1.485			
	5.000	0.990	60.000	1.510			
	5.000	0.970	65.000	1.530			
	5.000	0.950	70.000	1.550			
	5.000	0.975	75.000	1.525			
	5.000	0.995	80.000	1.505			
	0.000	0.895	0.000	1.605	0.000	80.000	119.167
115 L	5.000	0.950	5.000	1.550			
	5.000	1.005	10.000	1.495			
	5.000	1.015	15.000	1.485			**119.167**
	5.000	1.025	20.000	1.475			
	5.000	1.035	25.000	1.465			
	5.000	1.045	30.000	1.455			
	5.000	1.050	35.000	1.450			
	5.000	1.055	40.000	1.445			
	5.000	1.065	45.000	1.435			
	5.000	1.070	50.000	1.430			
	5.000	1.055	55.000	1.445			
	5.000	1.035	60.000	1.465			
	5.000	0.965	65.000	1.535			
	5.000	0.895	70.000	1.605			
	5.000	0.950	75.000	1.550			
	5.000	1.005	80.000	1.495			
	0.000	0.885	0.000	1.615	0.000	80.000	119.967
120 L	5.000	0.850	5.000	1.650			
	5.000	0.815	10.000	1.685			
	5.000	0.925	15.000	1.575			**119.967**
	5.000	1.035	20.000	1.465			
	5.000	1.090	25.000	1.410			

	5.000	1.145	30.000	1.355			
	5.000	1.095	35.000	1.405			
	5.000	1.045	40.000	1.455			
	5.000	1.075	45.000	1.425			
	5.000	1.100	50.000	1.400			
	5.000	1.090	55.000	1.410			
	5.000	1.075	60.000	1.425			
	5.000	0.955	65.000	1.545			
	5.000	0.835	70.000	1.665			
	5.000	0.925	75.000	1.575			
	5.000	1.015	80.000	1.485			
	0.000	0.880	0.000	1.620	0.000	80.000	117.433
125 L	5.000	0.885	5.000	1.615			
	5.000	0.890	10.000	1.610			
	5.000	0.960	15.000	1.540			**117.433**
	5.000	1.035	20.000	1.465			
	5.000	1.095	25.000	1.405			
	5.000	1.160	30.000	1.340			
	5.000	1.120	35.000	1.380			
	5.000	1.080	40.000	1.420			
	5.000	1.095	45.000	1.405			
	5.000	1.110	50.000	1.390			
	5.000	1.135	55.000	1.365			
	5.000	1.155	60.000	1.345			
	5.000	1.020	65.000	1.480			
	5.000	0.890	70.000	1.610			
	5.000	0.945	75.000	1.555			
	5.000	1.000	80.000	1.500			
	0.000	0.875	0.000	1.625	0.000	80.000	115.033
130 L	5.000	0.920	5.000	1.580			
	5.000	0.960	10.000	1.540			
	5.000	0.995	15.000	1.505			**115.033**
	5.000	1.030	20.000	1.470			
	5.000	1.100	25.000	1.400			
	5.000	1.170	30.000	1.330			
	5.000	1.145	35.000	1.355			
	5.000	1.115	40.000	1.385			
	5.000	1.115	45.000	1.385			
	5.000	1.115	50.000	1.385			
	5.000	1.175	55.000	1.325			
	5.000	1.230	60.000	1.270			
	5.000	1.085	65.000	1.415			
	5.000	0.940	70.000	1.560			
	5.000	0.965	75.000	1.535			
	5.000	0.985	80.000	1.515			
	0.000	0.980	0.000	1.520	0.000	80.000	114.300
135 L	5.000	0.990	5.000	1.510			
	5.000	0.995	10.000	1.505			
	5.000	1.010	15.000	1.490			**114.300**
	5.000	1.020	20.000	1.480			

	5.000	1.065	25.000	1.435			
	5.000	1.110	30.000	1.390			
	5.000	1.130	35.000	1.370			
	5.000	1.145	40.000	1.355			
	5.000	1.130	45.000	1.370			
	5.000	1.110	50.000	1.390			
	5.000	1.150	55.000	1.350			
	5.000	1.185	60.000	1.315			
	5.000	1.085	65.000	1.415			
	5.000	0.985	70.000	1.515			
	5.000	1.015	75.000	1.485			
	5.000	1.040	80.000	1.460			
	0.000	1.085	0.000	1.415	0.000	80.000	113.750
140 L	5.000	1.055	5.000	1.445			
	5.000	1.025	10.000	1.475			
	5.000	1.020	15.000	1.480			**113.750**
	5.000	1.010	20.000	1.490			
	5.000	1.030	25.000	1.470			
	5.000	1.050	30.000	1.450			
	5.000	1.115	35.000	1.385			
	5.000	1.175	40.000	1.325			
	5.000	1.140	45.000	1.360			
	5.000	1.100	50.000	1.400			
	5.000	1.120	55.000	1.380			
	5.000	1.135	60.000	1.365			
	5.000	1.085	65.000	1.415			
	5.000	1.030	70.000	1.470			
	5.000	1.065	75.000	1.435			
	5.000	1.095	80.000	1.405			
	0.000	1.105	0.000	1.395	0.000	80.000	115.433
145 L	5.000	1.075	5.000	1.425			
	5.000	1.045	10.000	1.455			
	5.000	1.045	15.000	1.455			**115.433**
	5.000	1.040	20.000	1.460			
	5.000	1.020	25.000	1.480			
	5.000	1.000	30.000	1.500			
	5.000	1.060	35.000	1.440			
	5.000	1.115	40.000	1.385			
	5.000	1.095	45.000	1.405			
	5.000	1.070	50.000	1.430			
	5.000	1.090	55.000	1.410			
	5.000	1.110	60.000	1.390			
	5.000	1.050	65.000	1.450			
	5.000	0.985	70.000	1.515			
	5.000	1.025	75.000	1.475			
	5.000	1.065	80.000	1.435			
	0.000	1.125	0.000	1.375	0.000	80.000	117.350
150 L	5.000	1.095	5.000	1.405			
	5.000	1.060	10.000	1.440			
	5.000	1.065	15.000	1.435			**117.350**

	5.000	1.070	20.000	1.430			
	5.000	1.010	25.000	1.490			
	5.000	0.945	30.000	1.555			
	5.000	1.000	35.000	1.500			
	5.000	1.050	40.000	1.450			
	5.000	1.045	45.000	1.455			
	5.000	1.035	50.000	1.465			
	5.000	1.060	55.000	1.440			
	5.000	1.080	60.000	1.420			
	5.000	1.010	65.000	1.490			
	5.000	0.935	70.000	1.565			
	5.000	0.985	75.000	1.515			
	5.000	1.035	80.000	1.465			
	0.000	1.090	0.000	1.410	0.000	80.000	116.833
155 L	5.000	1.065	5.000	1.435			
	5.000	1.035	10.000	1.465			
	5.000	1.050	15.000	1.450			**116.833**
	5.000	1.060	20.000	1.440			
	5.000	1.040	25.000	1.460			
	5.000	1.015	30.000	1.485			
	5.000	1.030	35.000	1.470			
	5.000	1.045	40.000	1.455			
	5.000	1.045	45.000	1.455			
	5.000	1.040	50.000	1.460			
	5.000	1.055	55.000	1.445			
	5.000	1.065	60.000	1.435			
	5.000	1.030	65.000	1.470			
	5.000	0.995	70.000	1.505			
	5.000	1.005	75.000	1.495			
	5.000	1.020	80.000	1.480			
	0.000	1.055	0.000	1.445	0.000	80.000	116.558
160 L	5.000	1.030	5.000	1.470			
	5.000	1.005	10.000	1.495			
	5.000	1.030	15.000	1.470			**116.558**
	5.000	1.050	20.000	1.450			
	5.000	1.065	25.000	1.435			
	5.000	1.080	30.000	1.420			
	5.000	1.060	35.000	1.440			
	5.000	1.040	40.000	1.460			
	5.000	1.040	45.000	1.460			
	5.000	1.040	50.000	1.460			
	5.000	1.045	55.000	1.455			
	5.000	1.050	60.000	1.450			
	5.000	1.050	65.000	1.450			
	5.000	1.050	70.000	1.450			
	5.000	1.025	75.000	1.475			
	5.000	1.000	80.000	1.500			
	0.000	1.055	0.000	1.445	0.000	80.000	117.008
165 L	5.000	1.045	5.000	1.455			
	5.000	1.040	10.000	1.460			

	5.000	1.025	15.000	1.475			**117.008**
	5.000	1.005	20.000	1.495			
	5.000	1.030	25.000	1.470			
	5.000	1.055	30.000	1.445			
	5.000	1.045	35.000	1.455			
	5.000	1.035	40.000	1.465			
	5.000	1.050	45.000	1.450			
	5.000	1.065	50.000	1.435			
	5.000	1.055	55.000	1.445			
	5.000	1.045	60.000	1.455			
	5.000	1.025	65.000	1.475			
	5.000	1.005	70.000	1.495			
	5.000	1.025	75.000	1.475			
	5.000	1.040	80.000	1.460			
	0.000	1.050	0.000	1.450	0.000	80.000	117.617
170 L	5.000	1.060	5.000	1.440			
	5.000	1.070	10.000	1.430			
	5.000	1.015	15.000	1.485			**117.617**
	5.000	0.960	20.000	1.540			
	5.000	0.995	25.000	1.505			
	5.000	1.030	30.000	1.470			
	5.000	1.030	35.000	1.470			
	5.000	1.030	40.000	1.470			
	5.000	1.060	45.000	1.440			
	5.000	1.085	50.000	1.415			
	5.000	1.060	55.000	1.440			
	5.000	1.035	60.000	1.465			
	5.000	1.000	65.000	1.500			
	5.000	0.960	70.000	1.540			
	5.000	1.020	75.000	1.480			
	5.000	1.080	80.000	1.420			
	0.000	1.080	0.000	1.420	0.000	80.000	117.733
175 L	5.000	1.065	5.000	1.435			
	5.000	1.055	10.000	1.445			
	5.000	1.000	15.000	1.500			**117.733**
	5.000	0.945	20.000	1.555			
	5.000	0.995	25.000	1.505			
	5.000	1.045	30.000	1.455			
	5.000	1.045	35.000	1.455			
	5.000	1.040	40.000	1.460			
	5.000	1.045	45.000	1.455			
	5.000	1.045	50.000	1.455			
	5.000	1.045	55.000	1.455			
	5.000	1.040	60.000	1.460			
	5.000	1.010	65.000	1.490			
	5.000	0.975	70.000	1.525			
	5.000	1.025	75.000	1.475			
	5.000	1.070	80.000	1.430			
	0.000	1.105	0.000	1.395	0.000	80.000	118.025
180 L	5.000	1.075	5.000	1.425			

	5.000	1.040	10.000	1.460			
	5.000	0.985	15.000	1.515			**118.025**
	5.000	0.930	20.000	1.570			
	5.000	0.995	25.000	1.505			
	5.000	1.060	30.000	1.440			
	5.000	1.055	35.000	1.445			
	5.000	1.050	40.000	1.450			
	5.000	1.025	45.000	1.475			
	5.000	1.000	50.000	1.500			
	5.000	1.025	55.000	1.475			
	5.000	1.045	60.000	1.455			
	5.000	1.015	65.000	1.485			
	5.000	0.985	70.000	1.515			
	5.000	1.025	75.000	1.475			
	5.000	1.060	80.000	1.440			
	0.000	1.045	0.000	1.455	0.000	80.000	119.125
185 L	5.000	1.030	5.000	1.470			
	5.000	1.015	10.000	1.485			
	5.000	0.985	15.000	1.515			**119.125**
	5.000	0.955	20.000	1.545			
	5.000	0.985	25.000	1.515			
	5.000	1.015	30.000	1.485			
	5.000	1.020	35.000	1.480			
	5.000	1.025	40.000	1.475			
	5.000	1.030	45.000	1.470			
	5.000	1.030	50.000	1.470			
	5.000	1.040	55.000	1.460			
	5.000	1.040	60.000	1.460			
	5.000	1.010	65.000	1.490			
	5.000	0.980	70.000	1.520			
	5.000	0.990	75.000	1.510			
	5.000	1.000	80.000	1.500			
	0.000	0.980	0.000	1.520	0.000	80.000	120.383
190 L	5.000	0.985	5.000	1.515			
	5.000	0.985	10.000	1.515			
	5.000	0.980	15.000	1.520			**120.383**
	5.000	0.975	20.000	1.525			
	5.000	0.975	25.000	1.525			
	5.000	0.970	30.000	1.530			
	5.000	0.985	35.000	1.515			
	5.000	1.000	40.000	1.500			
	5.000	1.030	45.000	1.470			
	5.000	1.060	50.000	1.440			
	5.000	1.050	55.000	1.450			
	5.000	1.035	60.000	1.465			
	5.000	1.005	65.000	1.495			
	5.000	0.970	70.000	1.530			
	5.000	0.955	75.000	1.545			
	5.000	0.940	80.000	1.560			

	0.000	1.005	0.000	1.495	0.000	80.000	118.625
195 L	5.000	1.005	5.000	1.495			
	5.000	1.010	10.000	1.490			
	5.000	1.015	15.000	1.485			**118.625**
	5.000	1.015	20.000	1.485			
	5.000	1.005	25.000	1.495			
	5.000	0.990	30.000	1.510			
	5.000	1.015	35.000	1.485			
	5.000	1.040	40.000	1.460			
	5.000	1.050	45.000	1.450			
	5.000	1.060	50.000	1.440			
	5.000	1.050	55.000	1.450			
	5.000	1.035	60.000	1.465			
	5.000	1.020	65.000	1.480			
	5.000	1.000	70.000	1.500			
	5.000	0.980	75.000	1.520			
	5.000	0.960	80.000	1.540			
	0.000	1.025	0.000	1.475	0.000	80.000	116.975
200 L	5.000	1.030	5.000	1.470			
	5.000	1.035	10.000	1.465			
	5.000	1.045	15.000	1.455			**116.975**
	5.000	1.055	20.000	1.445			
	5.000	1.035	25.000	1.465			
	5.000	1.010	30.000	1.490			
	5.000	1.045	35.000	1.455			
	5.000	1.075	40.000	1.425			
	5.000	1.065	45.000	1.435			
	5.000	1.055	50.000	1.445			
	5.000	1.045	55.000	1.455			
	5.000	1.035	60.000	1.465			
	5.000	1.035	65.000	1.465			
	5.000	1.030	70.000	1.470			
	5.000	1.005	75.000	1.495			
	5.000	0.980	80.000	1.520			
	0.000	1.060	0.000	1.440	0.000	80.000	117.125
205 L	5.000	1.035	5.000	1.465			
	5.000	1.010	10.000	1.490			
	5.000	1.030	15.000	1.470			**117.125**
	5.000	1.050	20.000	1.450			
	5.000	1.035	25.000	1.465			
	5.000	1.020	30.000	1.480			
	5.000	1.045	35.000	1.455			
	5.000	1.070	40.000	1.430			
	5.000	1.065	45.000	1.435			
	5.000	1.055	50.000	1.445			
	5.000	1.035	55.000	1.465			
	5.000	1.010	60.000	1.490			
	5.000	1.025	65.000	1.475			
	5.000	1.035	70.000	1.465			
	5.000	1.020	75.000	1.480			
	5.000	1.005	80.000	1.495			

	0.000	1.090	0.000	1.410	0.000	80.000	117.475
210 L	5.000	1.035	5.000	1.465			
	5.000	0.980	10.000	1.520			
	5.000	1.010	15.000	1.490			**117.475**
	5.000	1.040	20.000	1.460			
	5.000	1.035	25.000	1.465			
	5.000	1.025	30.000	1.475			
	5.000	1.045	35.000	1.455			
	5.000	1.065	40.000	1.435			
	5.000	1.060	45.000	1.440			
	5.000	1.055	50.000	1.445			
	5.000	1.020	55.000	1.480			
	5.000	0.985	60.000	1.515			
	5.000	1.015	65.000	1.485			
	5.000	1.040	70.000	1.460			
	5.000	1.035	75.000	1.465			
	5.000	1.025	80.000	1.475			

COMPUTATION OF FILLING QUANTITY FOR PART 3 OF MIG - PART				
Chainage (m)	C/S Area (m^2)			
5 L	104.477	5	45	4488.667
10 L	110.879	45	50	553.350
15 L	111.052	55	205	17401.467
20 L	111.370	205	210	587.000
25 L	114.651			
30 L	118.114			23030.484
35 L	113.747			
40 L	109.536			
45 L	110.227			
50 L	111.113			
55 L	112.275			
60 L	111.275			
65 L	113.075			
70 L	115.017			
75 L	115.158			
80 L	115.433			
85 L	111.892			
90 L	108.542			
95 L	112.142			
100 L	115.933			
105 L	117.100			
110 L	118.500			
115 L	119.167			
120 L	119.967			
125 L	117.433			
130 L	115.033			
135 L	114.300			
140 L	113.750			
145 L	115.433			
150 L	117.350			
155 L	116.833			
160 L	116.558			
165 L	117.008			
170 L	117.617			
175 L	117.733			
180 L	118.025			
185 L	119.125			
190 L	120.383			
195 L	118.625			
200 L	116.975			
205 L	117.125			
210 L	117.475			

COMPUTATION OF CROSS SECTIONAL AREA FOR PART 4 OF MIG - PART

Chainage (m)	Interval (m)	RL (m)	C.S (m)	Fill Depth (m)	Cross Sectional Area (m^2)		
5 R	0.000	1.095	0.000	1.405	0.000	80.000	75.417
	5.000	1.175	5.000	1.325	80.000	82.891	1.221
	5.000	1.255	10.000	1.245			
	5.000	1.230	15.000	1.270			
	5.000	1.205	20.000	1.295			**76.638**
	5.000	1.250	25.000	1.250			
	5.000	1.295	30.000	1.205			
	5.000	1.535	35.000	0.965			
	5.000	1.775	40.000	0.725			
	5.000	1.765	45.000	0.735			
	5.000	1.750	50.000	0.750			
	5.000	1.690	55.000	0.810			
	5.000	1.625	60.000	0.875			
	5.000	1.800	65.000	0.700			
	5.000	1.975	70.000	0.525			
	5.000	2.015	75.000	0.485			
	5.000	2.055	80.000	0.445			
	2.891	2.100	82.891	0.400			
10 R	0.000	0.725	0.000	1.775	0.000	80.000	76.675
	5.000	0.950	5.000	1.550	80.000	82.866	0.666
	5.000	1.175	10.000	1.325			
	5.000	1.235	15.000	1.265			
	5.000	1.290	20.000	1.210			**77.341**
	5.000	1.280	25.000	1.220			
	5.000	1.265	30.000	1.235			
	5.000	1.495	35.000	1.005			
	5.000	1.725	40.000	0.775			
	5.000	1.650	45.000	0.850			
	5.000	1.575	50.000	0.925			
	5.000	1.600	55.000	0.900			
	5.000	1.625	60.000	0.875			
	5.000	1.910	65.000	0.590			
	5.000	2.190	70.000	0.310			
	5.000	2.215	75.000	0.285			
	5.000	2.240	80.000	0.260			
	2.866	2.295	82.866	0.205			
15 R	0.000	0.970	0.000	1.530	0.000	80.000	71.375
	5.000	1.120	5.000	1.380	80.000	82.841	0.625
	5.000	1.270	10.000	1.230			
	5.000	1.270	15.000	1.230			
	5.000	1.270	20.000	1.230			**72.000**
	5.000	1.275	25.000	1.225			
	5.000	1.275	30.000	1.225			
	5.000	1.505	35.000	0.995			
	5.000	1.735	40.000	0.765			
	5.000	1.695	45.000	0.805			
	5.000	1.650	50.000	0.850			
	5.000	1.735	55.000	0.765			
	5.000	1.820	60.000	0.680			
	5.000	2.025	65.000	0.475			
	5.000	2.225	70.000	0.275			
	5.000	2.240	75.000	0.260			
	5.000	2.255	80.000	0.245			

INSTITUTE OF REMOTE SENSING
ANNA UNIVERSITY, CHENNAI 600025

	2.841	2.305	82.841	0.195			
20 R	0.000	1.210	0.000	1.290	0.000	80.000	66.283
	5.000	1.285	5.000	1.215	80.000	82.816	0.584
	5.000	1.360	10.000	1.140			
	5.000	1.305	15.000	1.195			
	5.000	1.245	20.000	1.255			**66.867**
	5.000	1.265	25.000	1.235			
	5.000	1.280	30.000	1.220			
	5.000	1.515	35.000	0.985			
	5.000	1.745	40.000	0.755			
	5.000	1.735	45.000	0.765			
	5.000	1.725	50.000	0.775			
	5.000	1.870	55.000	0.630			
	5.000	2.015	60.000	0.485			
	5.000	2.135	65.000	0.365			
	5.000	2.255	70.000	0.245			
	5.000	2.265	75.000	0.235			
	5.000	2.270	80.000	0.230			
	2.816	2.315	82.816	0.185			
25 R	0.000	1.175	0.000	1.325	0.000	80.000	72.583
	5.000	1.195	5.000	1.305	80.000	82.791	0.788
	5.000	1.220	10.000	1.280			
	5.000	1.260	15.000	1.240			
	5.000	1.295	20.000	1.205			**73.371**
	5.000	1.325	25.000	1.175			
	5.000	1.355	30.000	1.145			
	5.000	1.485	35.000	1.015			
	5.000	1.610	40.000	0.890			
	5.000	1.710	45.000	0.790			
	5.000	1.805	50.000	0.695			
	5.000	1.745	55.000	0.755			
	5.000	1.680	60.000	0.820			
	5.000	1.885	65.000	0.615			
	5.000	2.090	70.000	0.410			
	5.000	2.140	75.000	0.360			
	5.000	2.185	80.000	0.315			
	2.791	2.250	82.791	0.250			
30 R	0.000	1.135	0.000	1.365	0.000	80.000	79.117
	5.000	1.105	5.000	1.395	80.000	82.766	1.003
	5.000	1.075	10.000	1.425			
	5.000	1.210	15.000	1.290			
	5.000	1.340	20.000	1.160			**80.120**
	5.000	1.385	25.000	1.115			
	5.000	1.425	30.000	1.075			
	5.000	1.450	35.000	1.050			
	5.000	1.475	40.000	1.025			
	5.000	1.680	45.000	0.820			
	5.000	1.885	50.000	0.615			
	5.000	1.615	55.000	0.885			
	5.000	1.345	60.000	1.155			
	5.000	1.635	65.000	0.865			
	5.000	1.925	70.000	0.575			
	5.000	2.010	75.000	0.490			
	5.000	2.095	80.000	0.405			
	2.766	2.180	82.766	0.320			

35 R	0.000	1.175	0.000	1.325	0.000	80.000	82.283
	5.000	1.140	5.000	1.360	80.000	82.741	0.658
	5.000	1.100	10.000	1.400			
	5.000	1.165	15.000	1.335			
	5.000	1.230	20.000	1.270			**82.941**
	5.000	1.265	25.000	1.235			
	5.000	1.300	30.000	1.200			
	5.000	1.330	35.000	1.170			
	5.000	1.355	40.000	1.145			
	5.000	1.615	45.000	0.885			
	5.000	1.870	50.000	0.630			
	5.000	1.635	55.000	0.865			
	5.000	1.400	60.000	1.100			
	5.000	1.605	65.000	0.895			
	5.000	1.805	70.000	0.695			
	5.000	2.020	75.000	0.480			
	5.000	2.235	80.000	0.265			
	2.741	2.285	82.741	0.215			
40 R	0.000	1.210	0.000	1.290	0.000	80.000	85.625
	5.000	1.170	5.000	1.330	80.000	82.716	0.319
	5.000	1.125	10.000	1.375			
	5.000	1.120	15.000	1.380			
	5.000	1.115	20.000	1.385			**85.944**
	5.000	1.145	25.000	1.355			
	5.000	1.175	30.000	1.325			
	5.000	1.205	35.000	1.295			
	5.000	1.235	40.000	1.265			
	5.000	1.545	45.000	0.955			
	5.000	1.855	50.000	0.645			
	5.000	1.655	55.000	0.845			
	5.000	1.450	60.000	1.050			
	5.000	1.570	65.000	0.930			
	5.000	1.685	70.000	0.815			
	5.000	2.030	75.000	0.470			
	5.000	2.375	80.000	0.125			
	2.716	2.390	82.716	0.110			
45 R	0.000	1.260	0.000	1.240	0.000	80.000	85.433
	5.000	1.210	5.000	1.290	80.000	82.691	0.928
	5.000	1.135	10.000	1.365			
	5.000	1.120	15.000	1.380			
	5.000	1.105	20.000	1.395			**86.361**
	5.000	1.140	25.000	1.360			
	5.000	1.175	30.000	1.325			
	5.000	1.190	35.000	1.310			
	5.000	1.200	40.000	1.300			
	5.000	1.510	45.000	0.990			
	5.000	1.815	50.000	0.685			
	5.000	1.705	55.000	0.795			
	5.000	1.590	60.000	0.910			
	5.000	1.675	65.000	0.825			
	5.000	1.755	70.000	0.745			
	5.000	1.915	75.000	0.585			
	5.000	2.070	80.000	0.430			
	2.691	2.240	82.691	0.260			
50 R	0.000	1.305	0.000	1.195	0.000	80.000	85.567
	5.000	1.225	5.000	1.275	80.000	82.666	1.526

	5.000	1.145	10.000	1.355			
	5.000	1.120	15.000	1.380			
	5.000	1.095	20.000	1.405			**87.093**
	5.000	1.135	25.000	1.365			
	5.000	1.175	30.000	1.325			
	5.000	1.170	35.000	1.330			
	5.000	1.165	40.000	1.335			
	5.000	1.470	45.000	1.030			
	5.000	1.775	50.000	0.725			
	5.000	1.750	55.000	0.750			
	5.000	1.725	60.000	0.775			
	5.000	1.780	65.000	0.720			
	5.000	1.825	70.000	0.675			
	5.000	1.795	75.000	0.705			
	5.000	1.765	80.000	0.735			
	2.666	2.090	82.666	0.410			
55 R	0.000	1.375	0.000	1.125	0.000	80.000	82.008
	5.000	1.245	5.000	1.255	80.000	82.102	1.345
	5.000	1.115	10.000	1.385			
	5.000	1.105	15.000	1.395			
	5.000	1.095	20.000	1.405			**83.353**
	5.000	1.125	25.000	1.375			
	5.000	1.160	30.000	1.340			
	5.000	1.150	35.000	1.350			
	5.000	1.135	40.000	1.365			
	5.000	1.510	45.000	0.990			
	5.000	1.885	50.000	0.615			
	5.000	1.915	55.000	0.585			
	5.000	1.945	60.000	0.555			
	5.000	1.895	65.000	0.605			
	5.000	1.845	70.000	0.655			
	5.000	1.855	75.000	0.645			
	5.000	1.860	80.000	0.640			
	2.102	1.860	82.102	0.640			
60 R	0.000	1.440	0.000	1.060	0.000	80.000	78.525
	5.000	1.265	5.000	1.235	80.000	81.241	0.676
	5.000	1.085	10.000	1.415			
	5.000	1.090	15.000	1.410			
	5.000	1.090	20.000	1.410			**79.201**
	5.000	1.115	25.000	1.385			
	5.000	1.140	30.000	1.360			
	5.000	1.125	35.000	1.375			
	5.000	1.105	40.000	1.395			
	5.000	1.550	45.000	0.950			
	5.000	1.995	50.000	0.505			
	5.000	2.080	55.000	0.420			
	5.000	2.165	60.000	0.335			
	5.000	2.015	65.000	0.485			
	5.000	1.865	70.000	0.635			
	5.000	1.910	75.000	0.590			
	5.000	1.955	80.000	0.545			
	1.241	1.955	81.241	0.545			
65 R	0.000	1.280	0.000	1.220	0.000	80.000	81.625
	5.000	1.210	5.000	1.290	80.000	80.380	0.226
	5.000	1.140	10.000	1.360			
	5.000	1.115	15.000	1.385			

	5.000	1.085	20.000	1.415			**81.851**
	5.000	1.110	25.000	1.390			
	5.000	1.140	30.000	1.360			
	5.000	1.135	35.000	1.365			
	5.000	1.125	40.000	1.375			
	5.000	1.520	45.000	0.980			
	5.000	1.910	50.000	0.590			
	5.000	1.915	55.000	0.585			
	5.000	1.920	60.000	0.580			
	5.000	1.920	65.000	0.580			
	5.000	1.920	70.000	0.580			
	5.000	1.915	75.000	0.585			
	5.000	1.905	80.000	0.595			
	0.380	1.905	80.380	0.595			
70 R	0.000	1.115	0.000	1.385	0.000	70.000	79.050
	5.000	1.155	5.000	1.345	70.000	75.000	2.775
	5.000	1.195	10.000	1.305	75.000	79.520	2.780
	5.000	1.135	15.000	1.365			
	5.000	1.075	20.000	1.425			**84.605**
	5.000	1.105	25.000	1.395			
	5.000	1.135	30.000	1.365			
	5.000	1.140	35.000	1.360			
	5.000	1.145	40.000	1.355			
	5.000	1.485	45.000	1.015			
	5.000	1.825	50.000	0.675			
	5.000	1.750	55.000	0.750			
	5.000	1.675	60.000	0.825			
	5.000	1.825	65.000	0.675			
	5.000	1.975	70.000	0.525			
	5.000	1.915	75.000	0.585			
	4.520	1.855	79.520	0.645			
75 R	0.000	1.100	0.000	1.400	0.000	70.000	77.967
	5.000	1.115	5.000	1.385	70.000	75.000	2.163
	5.000	1.130	10.000	1.370	75.000	78.659	1.610
	5.000	1.105	15.000	1.395			
	5.000	1.075	20.000	1.425			**81.740**
	5.000	1.140	25.000	1.360			
	5.000	1.200	30.000	1.300			
	5.000	1.175	35.000	1.325			
	5.000	1.150	40.000	1.350			
	5.000	1.425	45.000	1.075			
	5.000	1.700	50.000	0.800			
	5.000	1.780	55.000	0.720			
	5.000	1.860	60.000	0.640			
	5.000	1.965	65.000	0.535			
	5.000	2.070	70.000	0.430			
	5.000	2.065	75.000	0.435			
	3.659	2.055	78.659	0.445			
80 R	0.000	1.085	0.000	1.415	0.000	70.000	76.950
	5.000	1.075	5.000	1.425	70.000	75.000	1.563
	5.000	1.065	10.000	1.435	75.000	77.798	0.748
	5.000	1.070	15.000	1.430			
	5.000	1.075	20.000	1.425			**79.261**
	5.000	1.170	25.000	1.330			
	5.000	1.265	30.000	1.235			
	5.000	1.210	35.000	1.290			

	5.000	1.155	40.000	1.345			
	5.000	1.365	45.000	1.135			
	5.000	1.575	50.000	0.925			
	5.000	1.810	55.000	0.690			
	5.000	2.045	60.000	0.455			
	5.000	2.105	65.000	0.395			
	5.000	2.165	70.000	0.335			
	5.000	2.210	75.000	0.290			
	2.798	2.255	77.798	0.245			
85 R	0.000	1.145	0.000	1.355	0.000	70.000	77.675
	5.000	1.145	5.000	1.355	70.000	75.000	0.650
	5.000	1.145	10.000	1.355	75.000	76.937	0.252
	5.000	1.115	15.000	1.385			
	5.000	1.080	20.000	1.420			**78.577**
	5.000	1.130	25.000	1.370			
	5.000	1.180	30.000	1.320			
	5.000	1.160	35.000	1.340			
	5.000	1.140	40.000	1.360			
	5.000	1.380	45.000	1.120			
	5.000	1.615	50.000	0.885			
	5.000	1.715	55.000	0.785			
	5.000	1.810	60.000	0.690			
	5.000	2.090	65.000	0.410			
	5.000	2.370	70.000	0.130			
	5.000	2.370	75.000	0.130			
	1.937	2.370	76.937	0.130			
90 R	0.000	1.205	0.000	1.295	0.000	70.000	78.500
	5.000	1.215	5.000	1.285	70.000	75.000	-0.250
	5.000	1.225	10.000	1.275	75.000	76.077	-0.027
	5.000	1.155	15.000	1.345			
	5.000	1.085	20.000	1.415			**78.223**
	5.000	1.090	25.000	1.410			
	5.000	1.095	30.000	1.405			
	5.000	1.110	35.000	1.390			
	5.000	1.125	40.000	1.375			
	5.000	1.390	45.000	1.110			
	5.000	1.655	50.000	0.845			
	5.000	1.615	55.000	0.885			
	5.000	1.575	60.000	0.925			
	5.000	2.075	65.000	0.425			
	5.000	2.575	70.000	-0.075			
	5.000	2.525	75.000	-0.025			
	1.077	2.525	76.077	-0.025			
95 R	0.000	1.140	0.000	1.360	0.000	70.000	77.342
	5.000	1.160	5.000	1.340	70.000	75.000	0.688
	5.000	1.175	10.000	1.325	75.000	75.216	0.026
	5.000	1.155	15.000	1.345			
	5.000	1.130	20.000	1.370			**78.056**
	5.000	1.120	25.000	1.380			
	5.000	1.110	30.000	1.390			
	5.000	1.115	35.000	1.385			
	5.000	1.115	40.000	1.385			
	5.000	1.435	45.000	1.065			
	5.000	1.755	50.000	0.745			
	5.000	1.745	55.000	0.755			
	5.000	1.730	60.000	0.770			

	5.000	2.040	65.000	0.460			
	5.000	2.345	70.000	0.155			
	5.000	2.380	75.000	0.120			
	0.216	2.380	75.216	0.120			
100 R	0.000	1.075	0.000	1.425	0.000	70.000	76.350
	5.000	1.100	5.000	1.400	70.000	74.355	1.415
	5.000	1.125	10.000	1.375			
	5.000	1.150	15.000	1.350			
	5.000	1.175	20.000	1.325			**77.765**
	5.000	1.150	25.000	1.350			
	5.000	1.125	30.000	1.375			
	5.000	1.115	35.000	1.385			
	5.000	1.105	40.000	1.395			
	5.000	1.480	45.000	1.020			
	5.000	1.855	50.000	0.645			
	5.000	1.870	55.000	0.630			
	5.000	1.885	60.000	0.615			
	5.000	2.000	65.000	0.500			
	5.000	2.115	70.000	0.385			
	4.355	2.235	74.355	0.265			
105 R	0.000	0.990	0.000	1.510	0.000	70.000	80.108
	5.000	1.040	5.000	1.460	70.000	73.494	1.005
	5.000	1.090	10.000	1.410			
	5.000	1.090	15.000	1.410			
	5.000	1.090	20.000	1.410			**81.113**
	5.000	1.095	25.000	1.405			
	5.000	1.100	30.000	1.400			
	5.000	1.085	35.000	1.415			
	5.000	1.065	40.000	1.435			
	5.000	1.365	45.000	1.135			
	5.000	1.665	50.000	0.835			
	5.000	1.785	55.000	0.715			
	5.000	1.905	60.000	0.595			
	5.000	2.030	65.000	0.470			
	5.000	2.155	70.000	0.345			
	3.494	2.270	73.494	0.230			
110 R	0.000	0.905	0.000	1.595	0.000	70.000	83.908
	5.000	0.980	5.000	1.520	70.000	72.634	0.665
	5.000	1.055	10.000	1.445			
	5.000	1.030	15.000	1.470			
	5.000	1.005	20.000	1.495			**84.573**
	5.000	1.040	25.000	1.460			
	5.000	1.075	30.000	1.425			
	5.000	1.050	35.000	1.450			
	5.000	1.025	40.000	1.475			
	5.000	1.250	45.000	1.250			
	5.000	1.475	50.000	1.025			
	5.000	1.700	55.000	0.800			
	5.000	1.925	60.000	0.575			
	5.000	2.060	65.000	0.440			
	5.000	2.190	70.000	0.310			
	2.634	2.305	72.634	0.195			
115 R	0.000	0.895	0.000	1.605	0.000	70.000	85.025
	5.000	0.985	5.000	1.515	70.000	71.773	0.421
	5.000	1.070	10.000	1.430			

	5.000	1.005	15.000	1.495			
	5.000	0.935	20.000	1.565			**85.446**
	5.000	1.005	25.000	1.495			
	5.000	1.075	30.000	1.425			
	5.000	1.045	35.000	1.455			
	5.000	1.015	40.000	1.485			
	5.000	1.220	45.000	1.280			
	5.000	1.425	50.000	1.075			
	5.000	1.675	55.000	0.825			
	5.000	1.925	60.000	0.575			
	5.000	2.065	65.000	0.435			
	5.000	2.200	70.000	0.300			
	1.773	2.325	71.773	0.175			
120 R	0.000	0.885	0.000	1.615	0.000	70.000	86.250
	5.000	0.985	5.000	1.515	70.000	70.912	0.269
	5.000	1.085	10.000	1.415			
	5.000	0.975	15.000	1.525			
	5.000	0.865	20.000	1.635			**86.519**
	5.000	0.970	25.000	1.530			
	5.000	1.075	30.000	1.425			
	5.000	1.040	35.000	1.460			
	5.000	1.005	40.000	1.495			
	5.000	1.190	45.000	1.310			
	5.000	1.375	50.000	1.125			
	5.000	1.650	55.000	0.850			
	5.000	1.925	60.000	0.575			
	5.000	2.065	65.000	0.435			
	5.000	2.205	70.000	0.295			
	0.912	2.205	70.912	0.295			
125 R	0.000	0.880	0.000	1.620	0.000	70.000	87.192
	5.000	0.960	5.000	1.540	70.000	70.051	0.019
	5.000	1.035	10.000	1.465			
	5.000	0.980	15.000	1.520			
	5.000	0.925	20.000	1.575			**87.211**
	5.000	1.010	25.000	1.490			
	5.000	1.090	30.000	1.410			
	5.000	1.070	35.000	1.430			
	5.000	1.045	40.000	1.455			
	5.000	1.235	45.000	1.265			
	5.000	1.420	50.000	1.080			
	5.000	1.585	55.000	0.915			
	5.000	1.750	60.000	0.750			
	5.000	1.945	65.000	0.555			
	5.000	2.135	70.000	0.365			
	0.051	2.135	70.051	0.365			
130 R	0.000	0.875	0.000	1.625	0.000	60.000	81.500
	5.000	0.930	5.000	1.570	60.000	65.000	4.013
	5.000	0.985	10.000	1.515	65.000	69.190	2.346
	5.000	0.985	15.000	1.515			
	5.000	0.985	20.000	1.515			**87.859**
	5.000	1.045	25.000	1.455			
	5.000	1.105	30.000	1.395			
	5.000	1.095	35.000	1.405			
	5.000	1.085	40.000	1.415			
	5.000	1.275	45.000	1.225			
	5.000	1.465	50.000	1.035			

	5.000	1.520	55.000	0.980			
	5.000	1.575	60.000	0.925			
	5.000	1.820	65.000	0.680			
	4.190	2.060	69.190	0.440			
135 R	0.000	0.980	0.000	1.520	0.000	60.000	80.875
	5.000	1.020	5.000	1.480	60.000	65.000	3.300
	5.000	1.055	10.000	1.445	65.000	68.330	1.565
	5.000	1.050	15.000	1.450			
	5.000	1.045	20.000	1.455			**85.740**
	5.000	1.060	25.000	1.440			
	5.000	1.075	30.000	1.425			
	5.000	1.070	35.000	1.430			
	5.000	1.060	40.000	1.440			
	5.000	1.185	45.000	1.315			
	5.000	1.310	50.000	1.190			
	5.000	1.530	55.000	0.970			
	5.000	1.745	60.000	0.755			
	5.000	1.935	65.000	0.565			
	3.330	2.125	68.330	0.375			
140 R	0.000	1.085	0.000	1.415	0.000	60.000	80.350
	5.000	1.105	5.000	1.395	60.000	65.000	2.588
	5.000	1.125	10.000	1.375	65.000	67.469	1.111
	5.000	1.115	15.000	1.385			
	5.000	1.105	20.000	1.395			**84.049**
	5.000	1.075	25.000	1.425			
	5.000	1.045	30.000	1.455			
	5.000	1.040	35.000	1.460			
	5.000	1.035	40.000	1.465			
	5.000	1.095	45.000	1.405			
	5.000	1.155	50.000	1.345			
	5.000	1.535	55.000	0.965			
	5.000	1.915	60.000	0.585			
	5.000	2.050	65.000	0.450			
	2.469	2.050	67.469	0.450			
145 R	0.000	1.105	0.000	1.395	0.000	60.000	80.767
	5.000	1.095	5.000	1.405	60.000	65.000	2.888
	5.000	1.085	10.000	1.415	65.000	66.608	0.868
	5.000	1.110	15.000	1.390			
	5.000	1.135	20.000	1.365			**84.523**
	5.000	1.100	25.000	1.400			
	5.000	1.065	30.000	1.435			
	5.000	1.040	35.000	1.460			
	5.000	1.010	40.000	1.490			
	5.000	1.070	45.000	1.430			
	5.000	1.130	50.000	1.370			
	5.000	1.510	55.000	0.990			
	5.000	1.885	60.000	0.615			
	5.000	1.960	65.000	0.540			
	1.608	1.960	66.608	0.540			
150 R	0.000	1.125	0.000	1.375	0.000	60.000	81.317
	5.000	1.085	5.000	1.415	60.000	65.000	3.188
	5.000	1.040	10.000	1.460	65.000	65.747	0.471
	5.000	1.100	15.000	1.400			
	5.000	1.160	20.000	1.340			**84.976**
	5.000	1.125	25.000	1.375			

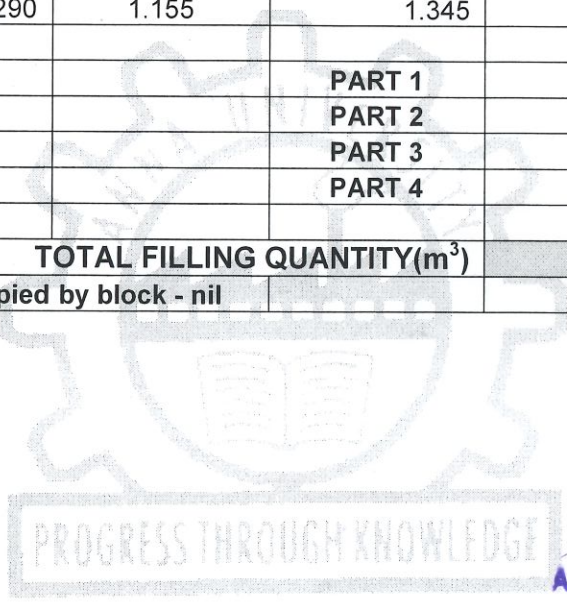
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	5.000	0.985	40.000	1.515			
	5.000	1.045	45.000	1.455			
	5.000	1.105	50.000	1.395			
	5.000	1.480	55.000	1.020			
	5.000	1.855	60.000	0.645			
	5.000	1.870	65.000	0.630			
	0.747	1.870	65.747	0.630			
155 R	0.000	1.090	0.000	1.410	0.000	60.000	81.567
	5.000	1.065	5.000	1.435	60.000	64.887	2.737
	5.000	1.035	10.000	1.465			
	5.000	1.070	15.000	1.430			
	5.000	1.110	20.000	1.390			**84.304**
	5.000	1.085	25.000	1.415			
	5.000	1.055	30.000	1.445			
	5.000	1.030	35.000	1.470			
	5.000	1.010	40.000	1.490			
	5.000	1.085	45.000	1.415			
	5.000	1.155	50.000	1.345			
	5.000	1.510	55.000	0.990			
	5.000	1.860	60.000	0.640			
	4.887	2.020	64.887	0.480			
160 R	0.000	1.055	0.000	1.445	0.000	60.000	82.017
	5.000	1.040	5.000	1.460	60.000	64.026	1.953
	5.000	1.025	10.000	1.475			
	5.000	1.040	15.000	1.460			
	5.000	1.055	20.000	1.445			**83.970**
	5.000	1.040	25.000	1.460			
	5.000	1.020	30.000	1.480			
	5.000	1.025	35.000	1.475			
	5.000	1.030	40.000	1.470			
	5.000	1.120	45.000	1.380			
	5.000	1.205	50.000	1.295			
	5.000	1.535	55.000	0.965			
	5.000	1.865	60.000	0.635			
	4.026	2.165	64.026	0.335			
165 R	0.000	1.055	0.000	1.445	0.000	60.000	80.775
	5.000	1.040	5.000	1.460	60.000	63.165	1.567
	5.000	1.025	10.000	1.475			
	5.000	1.045	15.000	1.455			
	5.000	1.065	20.000	1.435			**82.342**
	5.000	1.050	25.000	1.450			
	5.000	1.030	30.000	1.470			
	5.000	1.035	35.000	1.465			
	5.000	1.035	40.000	1.465			
	5.000	1.170	45.000	1.330			
	5.000	1.305	50.000	1.195			
	5.000	1.585	55.000	0.915			
	5.000	1.860	60.000	0.640			
	3.165	2.150	63.165	0.350			
170 R	0.000	1.050	0.000	1.450	0.000	60.000	79.758
	5.000	1.035	5.000	1.465	60.000	62.304	1.486
	5.000	1.020	10.000	1.480			
	5.000	1.045	15.000	1.455			

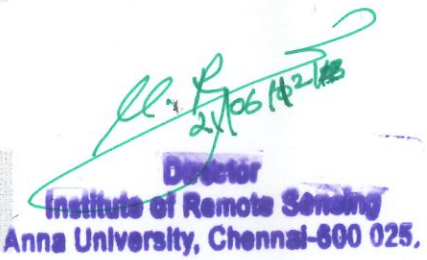
	5.000	1.070	20.000	1.430			**81.244**
	5.000	1.055	25.000	1.445			
	5.000	1.040	30.000	1.460			
	5.000	1.040	35.000	1.460			
	5.000	1.035	40.000	1.465			
	5.000	1.220	45.000	1.280			
	5.000	1.405	50.000	1.095			
	5.000	1.630	55.000	0.870			
	5.000	1.855	60.000	0.645			
	2.304	1.855	62.304	0.645			
175 R	0.000	1.080	0.000	1.420	0.000	60.000	79.083
	5.000	1.065	5.000	1.435	60.000	61.444	0.563
	5.000	1.045	10.000	1.455			
	5.000	1.075	15.000	1.425			
	5.000	1.105	20.000	1.395			**79.646**
	5.000	1.090	25.000	1.410			
	5.000	1.070	30.000	1.430			
	5.000	1.055	35.000	1.445			
	5.000	1.035	40.000	1.465			
	5.000	1.135	45.000	1.365			
	5.000	1.235	50.000	1.265			
	5.000	1.675	55.000	0.825			
	5.000	2.110	60.000	0.390			
	1.444	2.110	61.444	0.390			
180 R	0.000	1.105	0.000	1.395	0.000	60.000	78.567
	5.000	1.090	5.000	1.410	60.000	60.583	0.079
	5.000	1.070	10.000	1.430			
	5.000	1.105	15.000	1.395			
	5.000	1.140	20.000	1.360			**78.646**
	5.000	1.120	25.000	1.380			
	5.000	1.100	30.000	1.400			
	5.000	1.065	35.000	1.435			
	5.000	1.030	40.000	1.470			
	5.000	1.050	45.000	1.450			
	5.000	1.065	50.000	1.435			
	5.000	1.715	55.000	0.785			
	5.000	2.365	60.000	0.135			
	0.583	2.365	60.583	0.135			
185 R	0.000	1.045	0.000	1.455	0.000	50.000	71.175
	5.000	1.040	5.000	1.460	50.000	55.000	5.800
	5.000	1.035	10.000	1.465	55.000	59.722	3.412
	5.000	1.060	15.000	1.440			
	5.000	1.085	20.000	1.415			**80.387**
	5.000	1.095	25.000	1.405			
	5.000	1.105	30.000	1.395			
	5.000	1.090	35.000	1.410			
	5.000	1.070	40.000	1.430			
	5.000	1.100	45.000	1.400			
	5.000	1.120	50.000	1.380			
	5.000	1.560	55.000	0.940			
	4.722	1.995	59.722	0.505			
190 R	0.000	0.980	0.000	1.520	0.000	50.000	71.742
	5.000	0.990	5.000	1.510	50.000	55.000	6.063
	5.000	0.995	10.000	1.505	55.000	58.861	3.813
	5.000	1.015	15.000	1.485			

	5.000	1.030	20.000	1.470			**81.618**
	5.000	1.070	25.000	1.430			
	5.000	1.105	30.000	1.395			
	5.000	1.110	35.000	1.390			
	5.000	1.110	40.000	1.390			
	5.000	1.145	45.000	1.355			
	5.000	1.175	50.000	1.325			
	5.000	1.400	55.000	1.100			
	3.861	1.625	58.861	0.875			
195 R	0.000	1.005	0.000	1.495	0.000	50.000	71.283
	5.000	1.025	5.000	1.475	50.000	55.000	5.938
	5.000	1.040	10.000	1.460	55.000	58.001	2.866
	5.000	1.040	15.000	1.460			
	5.000	1.035	20.000	1.465			**80.087**
	5.000	1.080	25.000	1.420			
	5.000	1.120	30.000	1.380			
	5.000	1.095	35.000	1.405			
	5.000	1.070	40.000	1.430			
	5.000	1.135	45.000	1.365			
	5.000	1.195	50.000	1.305			
	5.000	1.430	55.000	1.070			
	3.001	1.660	58.001	0.840			
200 R	0.000	1.025	0.000	1.475	0.000	50.000	70.983
	5.000	1.055	5.000	1.445	50.000	55.000	5.825
	5.000	1.080	10.000	1.420	55.000	57.140	2.236
	5.000	1.060	15.000	1.440			
	5.000	1.035	20.000	1.465			**79.044**
	5.000	1.085	25.000	1.415			
	5.000	1.130	30.000	1.370			
	5.000	1.080	35.000	1.420			
	5.000	1.030	40.000	1.470			
	5.000	1.125	45.000	1.375			
	5.000	1.215	50.000	1.285			
	5.000	1.455	55.000	1.045			
	2.140	1.455	57.140	1.045			
205 R	0.000	1.060	0.000	1.440	0.000	50.000	69.925
	5.000	1.075	5.000	1.425	50.000	55.000	5.238
	5.000	1.090	10.000	1.410	55.000	56.279	1.241
	5.000	1.070	15.000	1.430			
	5.000	1.050	20.000	1.450			**76.404**
	5.000	1.095	25.000	1.405			
	5.000	1.135	30.000	1.365			
	5.000	1.075	35.000	1.425			
	5.000	1.010	40.000	1.490			
	5.000	1.195	45.000	1.305			
	5.000	1.375	50.000	1.125			
	5.000	1.530	55.000	0.970			
	1.279	1.530	56.279	0.970			

COMPUTATION OF FILLING QUANTITY FOR PART 4 OF MIG - PART				
Chainage (m)	**C/S Area (m^2)**			
5 R	76.638	5 R	205 R	**16278.020**
10 R	77.341			
15 R	72.000			
20 R	66.867			
25 R	73.371			
30 R	80.120			
35 R	82.941			
40 R	85.944			
45 R	86.361			
50 R	87.093			
55 R	83.353			
60 R	79.201			
65 R	81.851			
70 R	84.605			
75 R	81.740			
80 R	79.261			
85 R	78.577			
90 R	78.223			
95 R	78.056			
100 R	77.765			
105 R	81.113			
110 R	84.573			
115 R	85.446			
120 R	86.519			
125 R	87.211			
130 R	87.859			
135 R	85.740			
140 R	84.049			
145 R	84.523			
150 R	84.976			
155 R	84.304			
160 R	83.970			
165 R	82.342			
170 R	81.244			
175 R	79.646			
180 R	78.646			
185 R	80.387			
190 R	81.618			
195 R	80.087			
200 R	79.044			
205 R	76.404			

COMPUTATION OF FILLING QUANTITY FOR MIG - PART				
Polygon No.	Polygon Area(m^2)	Average RL(m)	Average Fill Depth(m)	Volume(m^3)
1	0.265868	1.035	1.465	0.389
2	0.53111	1.010	1.490	0.791
3	0.887217	0.930	1.570	1.393
4	261.975573	1.007	1.493	391.230
5	0.493535	0.970	1.530	0.755
6	700.246812	0.935	1.565	1095.886
7	312.046744	1.185	1.315	410.479
8	398.295458	1.090	1.410	561.597
9	588.13677	1.035	1.465	861.620
10	305.348006	1.595	0.905	276.340
11	0.420293	1.890	0.610	0.256
12	0.135274	2.380	0.120	0.016
13	0.00762	2.135	0.365	0.003
14	1.622387	1.920	0.580	0.941
15	0.986498	2.240	0.260	0.256
16	337.290	1.155	1.345	453.656
			PART 1	**19824.565**
			PART 2	**30693.083**
			PART 3	**23030.484**
			PART 4	**16278.020**
TOTAL FILLING QUANTITY(m^3)				**93881.761**
NOTE: Volume occupied by block - nil				





2.5.4 Layout Plan

TAMIL NADU
SLUM CLEARANCE BOARD

TENTATIVE SITE PLAN FOR CONSTRUCTION OF (G+5)FLOORS 1152 TENEMENTS AT NUKKAMPALAYAM ROAD, PERUMBAKKAM, CHENNAI IN S.NOS.479/2, 482, 483, 484, 485, 508, 509, 510, 511, 516, 517, 518, 523, 524/1, 524/2, 536/1, 537, 538, 539/2, 540/1, 540/2 & 541 PERUMBAKKAM VILLAGE, TAMBARAM TALUK, KANCHIPURAM DISTRICT.

REFERENCE:

ADOPTED TYPE DESIGN NO.	-	37C/2019.
NO. OF FLOORS	-	G+5 FLOORS.
PLINTH AREA / UNIT	-	37.74 sq.m.
NUMBER OF BLOCKS	-	12 Nos. [16 IN 1]
NO. OF UNITS	-	1152 Nos.

AREA STATEMENT:

PLOT EXTENT (as per drawing)	-	33595.98sq.m.
DENSITY	-	343 units/Hect.
FLOOR SPACE INDEX (FSI)	-	1.30
PLOT COVERAGE	-	21.67 %

LAND USE DTAILS:

Sl.No.	USE	AREA in sq.m	LAND in %	NOTATION
1.	RESIDENTIAL	12224.82	36.39%	
2.	PARK	3359.96	10.00%	
3.	PUBLIC PURPOSE	1717.54	5.11%	
4.	INTERNAL ROADS	6876.79	20.47%	
5.	COMMERICAL	4373.77	13.02 %	
6.	GREEN BELT	5043.09	15.01 %	
	TOTAL	33595.97	100.00 %	

SOLAR CALCULATION DETAILS :

NO. OF TENEMENTS	: 1152 Nos.
NO. OF PERSONS/FAMILY	: 5.0 Persons.
TOTAL NO. OF PERSONS	: 5760 Nos.
REQUIRED WATER FOR 1PERSION	: 60 Lit/Day
TOTAL WATER REQUIREMENT (5760 x 60)	: 3,45,600 Lit /Day
ONE SOLAR CAPACITY	: 3000 Lit
REQUIRED SOLAR (345600/3000)	: 115 Nos.

NO	DATE	REVISION	PROP.	CHKD.	DEALT.	APPD.

NOTE:

1. ALL DIMENSIONS ARE IN METER.
2. THE TYPED DESIGN TO BE ADOPTED FOR PERUMBAKKAM SCHEME.

SCALE. 1:400	PROJECT	PERUMBAKKAM
SIZE A1	DWG. TITLE	SITE PLAN
DWG. NO.	TNSCB/SP/PM/SITE PLAN	REV. 01
FILE LOC.	D-TNSCB-LAYOUT- CH - PERUMBAKKAM	

TECHNICAL ASST.	PLANNING ASST.
ASST. PLANNER	
SENIOR PLANNER	CHIEF ENGINEER

DWARF WALL@ ENTRANCE

RAIN WATER COLLECTION TRENCH

TAMIL NADU
SLUM CLEARANCE BOARD

PROPOSED PART LAYOUT FOR CONSTRUCTION OF MULTI-STOREYED TENEMENTS AT NUKKAMPALAYAM ROAD, PERUMBAKKAM, CHENNAI IN S.NOS.479/2, 482, 483, 484, 485, 508, 509, 510, 511, 516, 517, 518, 523, 524/1, 524/2, 536/1, 537, 538, 539/2, 540/1, 540/2 & 541 PERUMBAKKAM VILLAGE, TAMBARAM TALUK, KANCHIPURAM DISTRICT.

REFERENCE:

PERUMBAKKAM TYPE DESIGN (A)

AS PER TYPE DESIGN - 7/2008 (G+7)
PLINTH AREA - 36.22 sq.m
192 UNITS/BLOCK
11 x 186 = 2046
(GROUND FLOOR 6 UNITS USED FOR ELECTICAL AND OTHER AMENITIES)

EZHIL NAGAR TYPE DESIGN (B)

AS PER TYPE DESIGN - 9/2008 (G+7)
PLINTH AREA - 28.87 sq.m
192 UNITS / BLOCK
21 x 186 = 3906
(GROUND FLOOR 6 UNITS USED FOR ELECTICAL AND OTHER AMENITIES)

PERUMBAKKAM PHASE-II TYPE DESIGN (C)

AS PER TYPE DESIGN - 7A/2008 (G+7)
PLINTH AREA - 37.18 sq.m
96 UNITS / BLOCK
154 x 94 = 14476
(GROUND FLOOR 2 UNITS USED FOR ELECTICAL AND OTHER AMENITIES)

NAME OF THE SCHEME	NO. OF BLOCKS	NO. OF UNITS FLOOR	TOTAL NO. OF UNITS	UNITS ALLOCATED FOR ELECTRICITY & OTHER AMENITIES	BALANCE NO. OF DWELLING UNITS
PERUMBAKKAM	11	192	2112	66	2046
EZHIL NAGAR	21	192	4032	126	3906
PERUMBAKKAM PH-II	154	96	14784	462	14322
TOTAL	186		20928	654	20274

AREA STATEMENT

EXTENT (as per document)	- 81.20 HECT
EXTENT (as per patta)	- 81.20 HECT
EXTENT (as per site)	- 22.0715 HECT
DENSITY	- 348 / HECT
F.S.I	- 1.1026
PLOT COVERAGE	- 13.8%

FLOOR WISE AREA DETAILS:

NAME OF THE FLOOR	7/2008 (A) FSI AREA (sq.m)	7/2008 (A) NON FSI AREA (sq.m)	9/2008 (B) FSI AREA (sq.m)	9/2008 (B) NON FSI AREA (sq.m)	9/2008 (C) FSI AREA (sq.m)	9/2008 (C) NON FSI AREA (sq.m)
G. FLOOR	677.46	176.50	542.57	138.41	375.08	58.16
1st FLOOR	853.96	--	680.98	--	433.24	--
2nd FLOOR	853.96	--	680.98	--	433.24	--
3rd FLOOR	853.96	--	680.98	--	433.24	--
4th FLOOR	853.96	--	680.98	--	433.24	--
5th FLOOR	853.96	--	680.98	--	433.24	--
6th FLOOR	853.96	--	680.98	--	433.24	--
7th FLOOR	853.96	--	680.98	--	433.24	--

PARK AREA DETAILS:

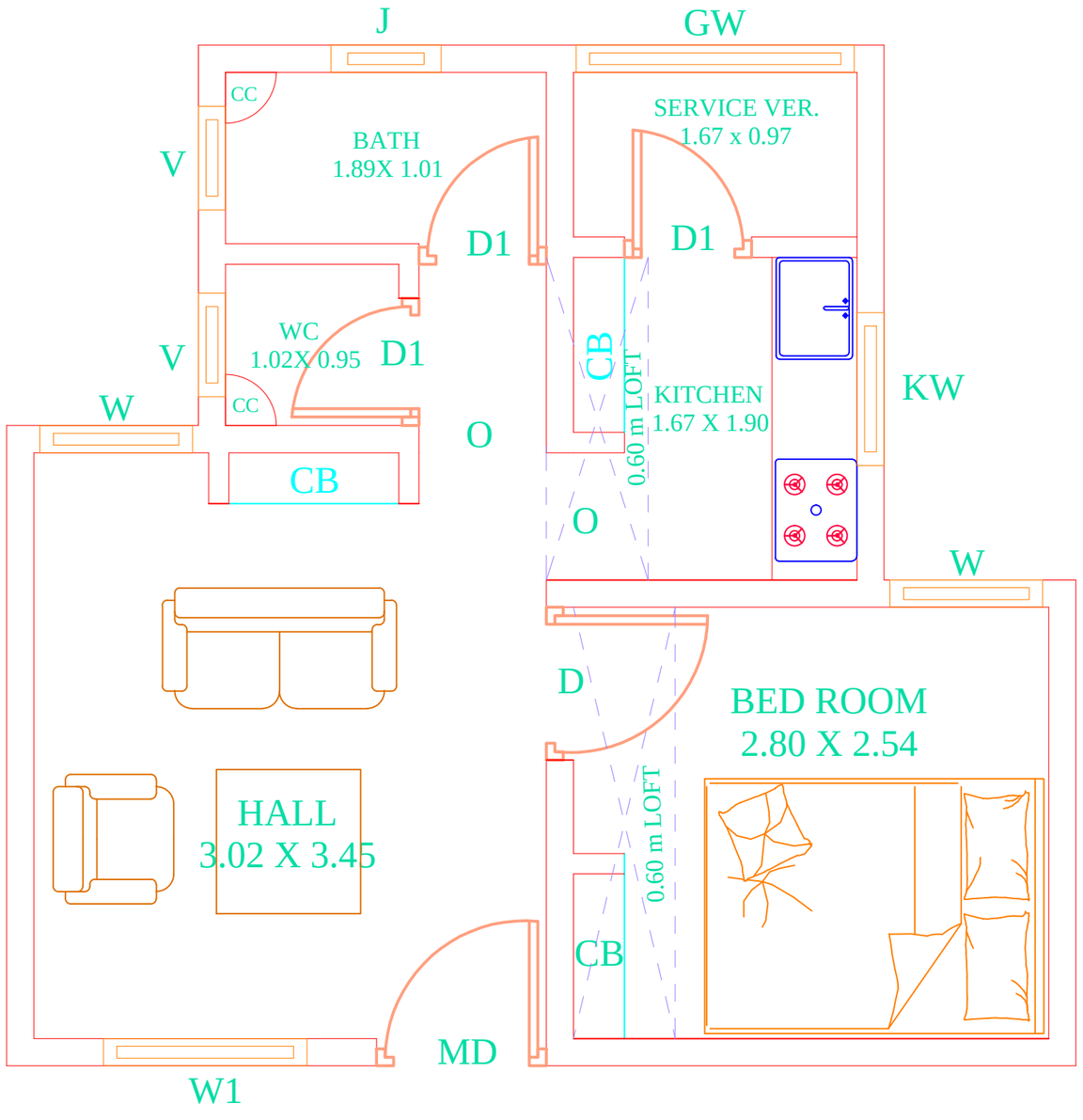
EXISTING - 11466.0 sq.m (BELOW PROPOSED 18.0m ROAD-1)
PARK - 10 - 977.2 sq.m
PARK - 11 - 435.7 sq.m
PARK - 12 - 869.2 sq.m
PARK - 13 - 2988.3 sq.m
PARK - 14 - 607.9 sq.m
PARK - 15 - 1010.9 sq.m
PARK - 16 - 1265.5 sq.m
PARK - 17 - 663.9 sq.m
PARK - 18 - 31053.7 sq.m
PARK - 19 - 2051.9 sq.m
PARK - 20 - 845.8 sq.m
PARK - 21 - 714.3 sq.m
PARK - 22 - 2181.2 sq.m
PARK - 23 - 466.3 sq.m
PARK - 24 - 1289.9 sq.m
PARK - 25 - 746.3 sq.m
PARK - 26 - 3391.5 sq.m
PARK - 27 - 5206.2 sq.m
PARK - 28 - 1769.2 sq.m
PARK - 29 - 782.8 sq.m
PARK - 30 - 721.1 sq.m
PARK - 31 - 658.9 sq.m
PARK - 32 - 1138.3 sq.m
PARK - 33 - 3078.4 sq.m
G.B - 1 - 163.2 sq.m
G.B - 2 - 67.1sq.m
G.B - 3 - 87.0 sq.m
G.B - 4 - 1085.7 sq.m
G.B - 5 - 163.2 sq.m
G.B - 6 - 98.7 sq.m
G.B - 7 - 84.6 sq.m
G.B - 8 - 111.0 sq.m
TOTAL - 81200.1 sq.m
PARK AREA - 10.0%

NOTE:
- SUMP FOR SULLAGE WATER
- SUMP FOR FIRE FIGHTING WATER
- SUMP FOR DRINKING WATER
- SUMP FOR RAIN WATER COLLECTION

SCALE - 1:1200

PLANNING ASST.	PLANNING ASST.
SENIOR PLANNER	CHIEF ENGINEER

2.5.5 Unit Plan



TAMIL NADU
SLUM CLEARANCE BOARD

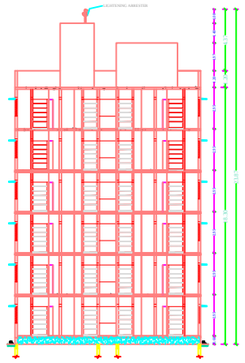
SCHEDULE OF JOINERIES

TYPE	DESCRIPTION	SIZE
MD	Solid core flush door	1.00 x 2.10
D	Solid core flush door	0.90 x 2.10
D1	Solid core PVC door	0.75 x 2.10
O	OPENING	0.75 x 2.10
W	UPVC sliding Window	0.90 x 1.20
W1	UPVC sliding Window	1.20 x 1.20
J	JALLY VENTILATOR	0.65 x 0.65
KW	UPVC sliding Window	0.90 x 1.20
G	GRIL	1.64 x 1.20
V	UPVC VENTILATOR	0.61 x 0.61

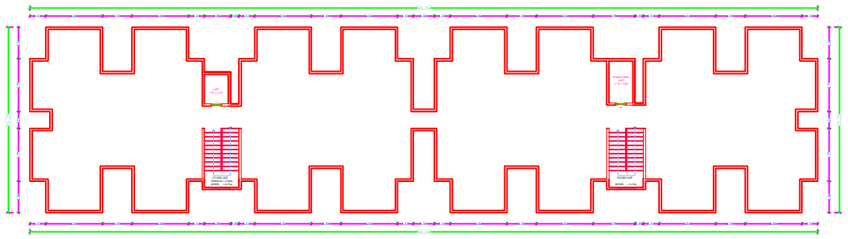
2.5.6 Floor Plans



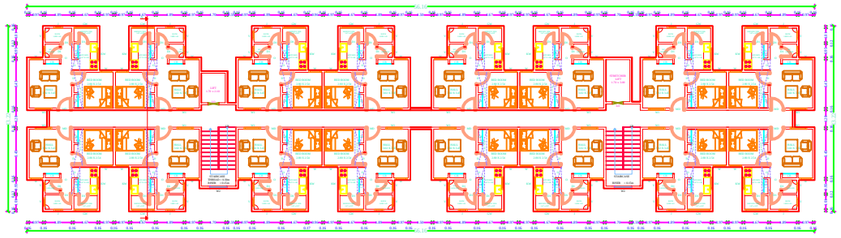
FRONT ELEVATION



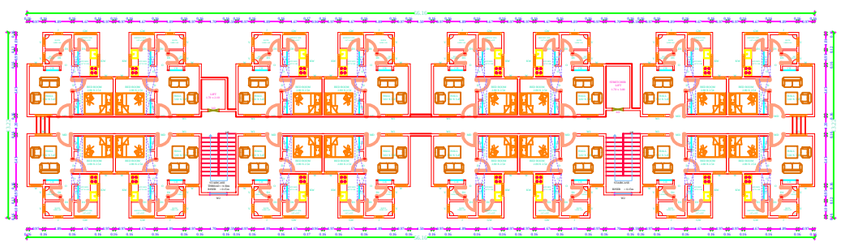
SECTION AA'



TERRACE FLOOR PLAN



TYPICAL FLOOR PLAN I ,II,III & V



GROUND FLOOR PLAN

TAMIL NADU SLUM CLEARANCE BOARD

SHEET : 2/2

T.D.NO. 37C/2019
(BLOCK NO.01-12)
(GROUND +5 FLOORS)
(16 DWELLING UNIT / FLOOR)
[96 DWELLING UNIT/BLOCK]

TENTATIVE SITE PLAN FOR CONSTRUCTION OF (G+5)FLOORS 1152 TENEMENTS AT NUKKAMPALAYAM ROAD, PERUMBAKKAM, CHENNAI IN S.NOS.479/2, 482, 483, 484, 485, 508, 509, 510, 511, 516, 517, 518, 523, 524/1, 524/2, 536/1, 537, 538, 539/2, 540/1, 540/2 & 541 PERUMBAKKAM VILLAGE, TAMBARAM TALUK, KANCHIPURAM DISTRICT.

AREA DETAILS:

PLINTH AREA / UNIT (INCLUDING COMMON AREA)	- 37.74 sq.m
COMMON AREA / UNIT	- 6.20 sq.m
PLINTH AREA / UNIT (EXCLUDING COMMON AREA)	- 31.54 sq.m
CARPET AREA / UNIT	- 26.58 sq.m

SCHEDULE OF JOINERIES

TYPE	DESCRIPTION	SIZE
MD	Solid core flush door	1.00 x 2.10
D	Solid core flush door	0.90 x 2.10
D1	Solid core PVC door	0.75 x 2.10
O	OPENING	0.75 x 2.10
W	UPVC sliding Window	0.90 x 1.20
W1	UPVC sliding Window	1.20 x 1.20
J	JALLY VENTILATOR	0.65 x 0.65
KW	UPVC sliding Window	0.90 x 1.20
G	GRIL	1.64 x 1.20
V	UPVC VENTILATOR	0.61 x 0.61

NO	DATE	REVISION	PROP.	CHKD.	DEALT.	APPD.

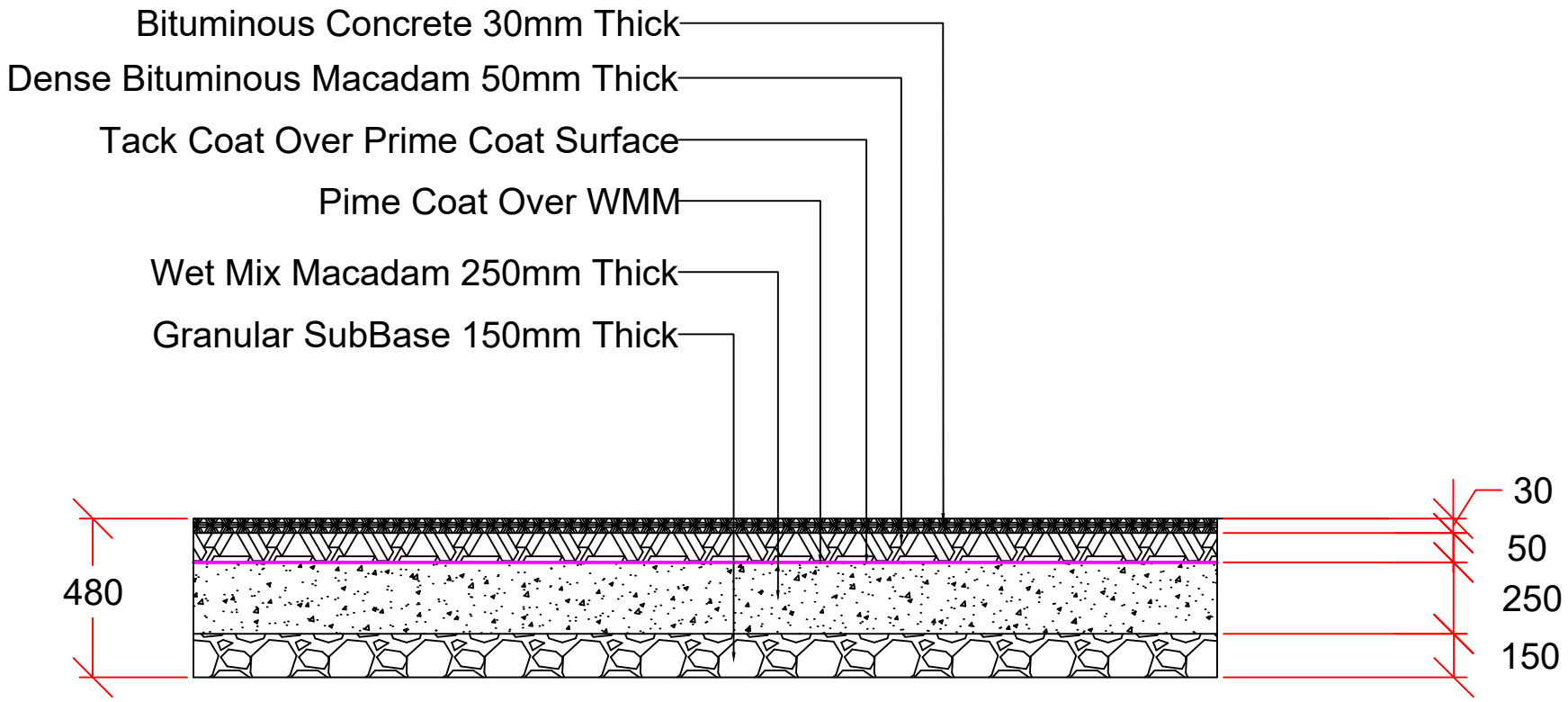
NOTE:

1. ALL DIMENSIONS ARE IN METER.
2. THE TYPED DESIGN TO BE ADOPTED FOR PERUMBAKKAM SCHEME.

SCALE. 1:400	PROJECT	**PERUMBAKKAM**
SIZE A3	DWG. TITLE	TYPE DESIGN
DWG. NO.	TNSCB/SP/PM/TYPE DESIGN	REV. 00
FILE LOC.	D- LAYOUTS -CHENNAI- CH - PERUMBAKKAM	

TECHNICAL ASST.	PLANNING ASST.
ASST. PLANNER	
SENIOR PLANNER	CHIEF ENGINEER

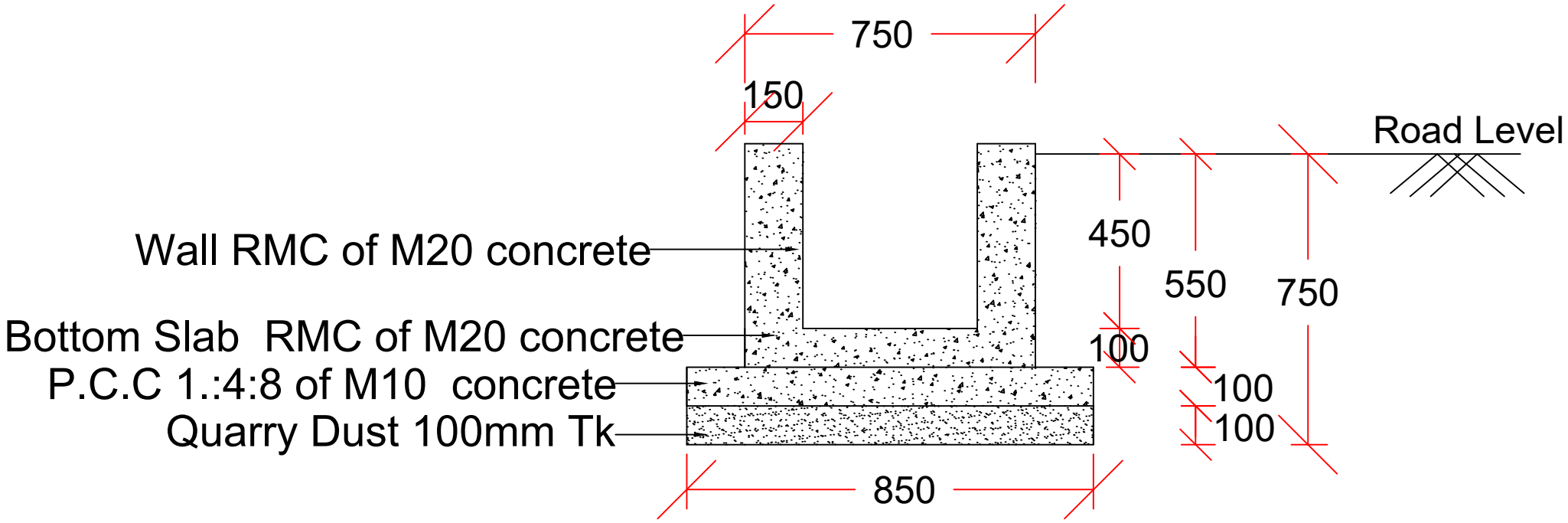
2.5.7 Physical Infrastructure Drawings

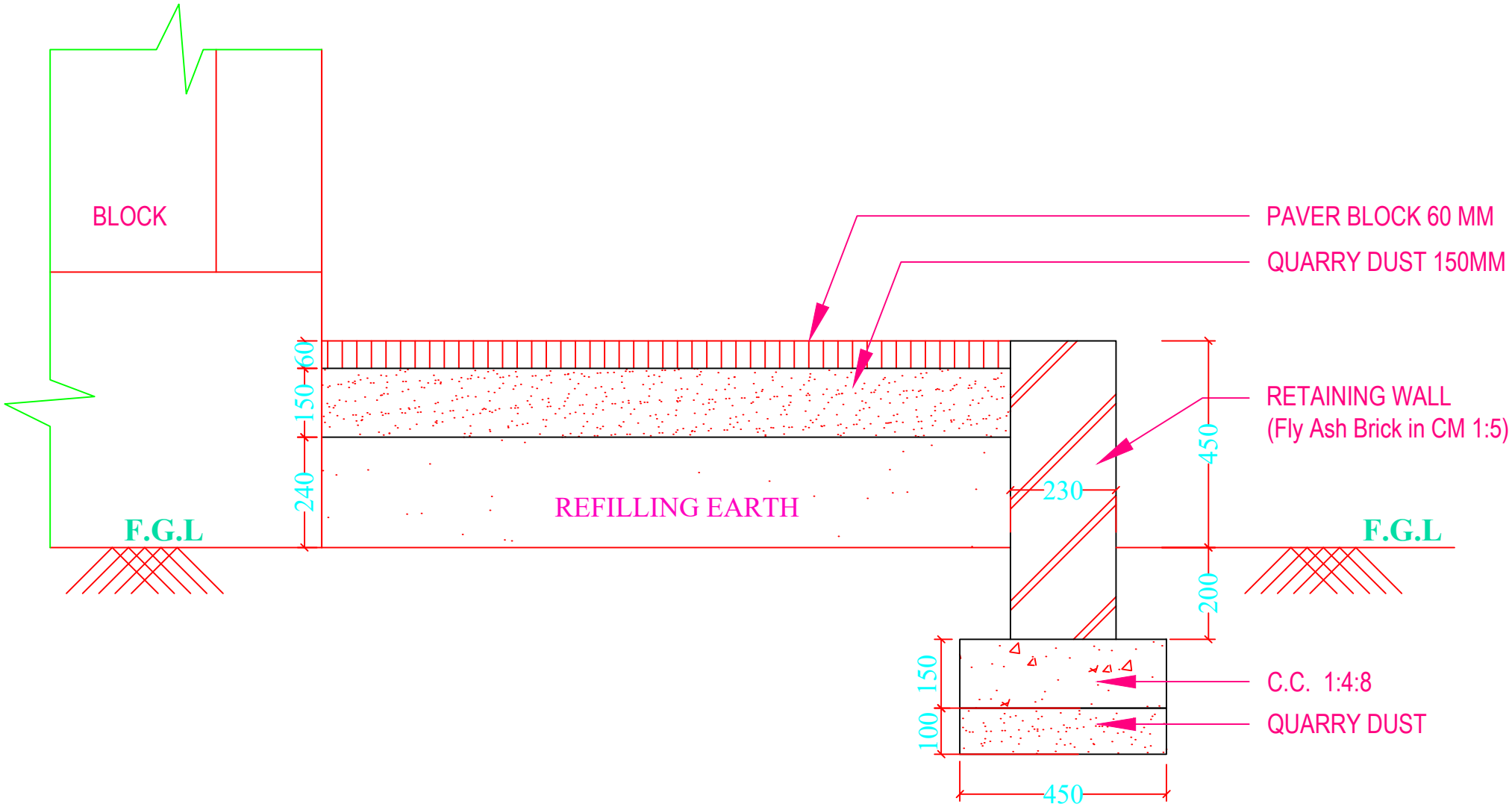


CROSS SECTION OF ROAD

Not to Scale

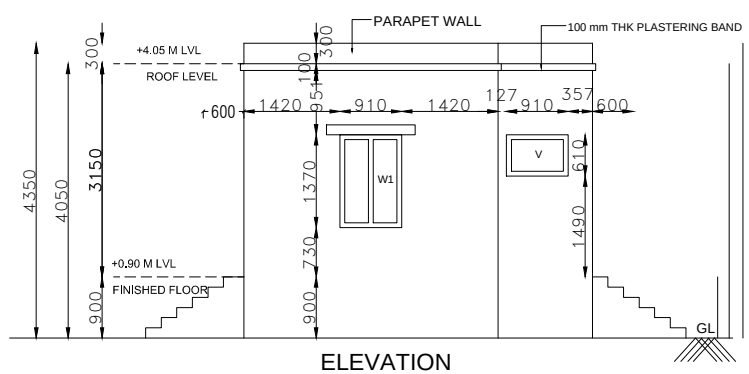
Cross Section of Proposed Storm Water Drain at Perumbakkam under GHTC - I



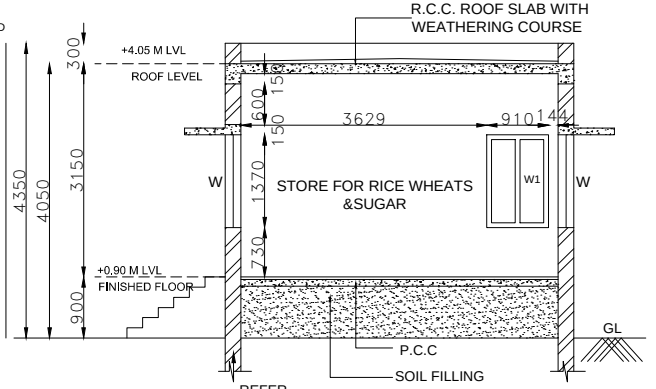


C.S. OF PAVER BLOCK

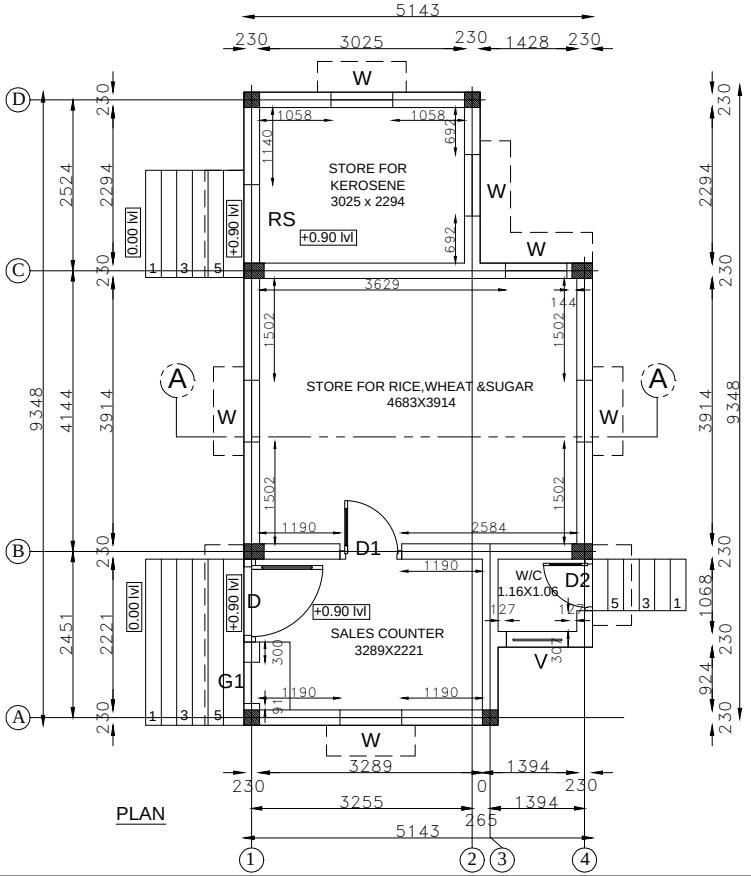
2.5.8 Social Infrastructure Building Drawings



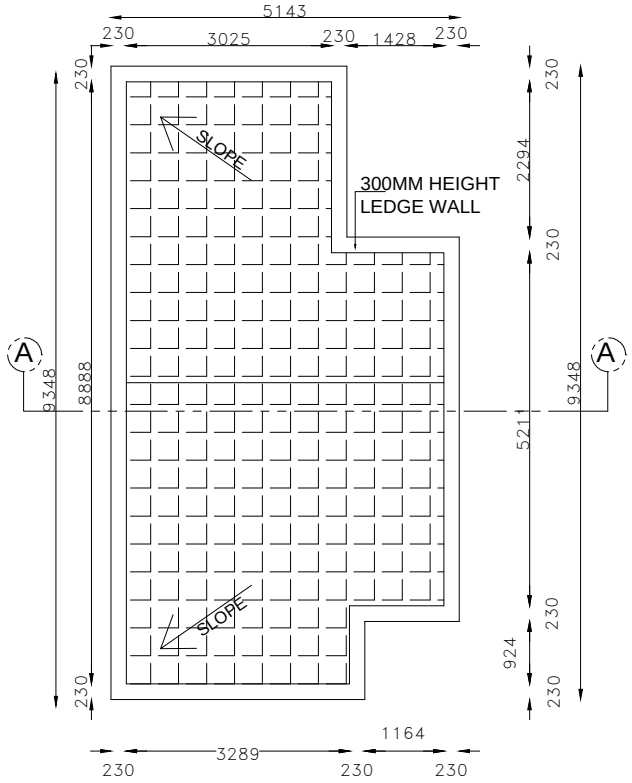
ELEVATION



SECTION - AA



PLAN



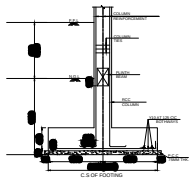
TERRACE FLOOR PLAN

SHEET NO - 07 / 11

SCHEDULE OF JOINERY

S.NO	TYPE	DESCRIPTION		SIZE(MM)	NOS
1	RS	ROLLING SHUTTER	STEEL ROLLING SHUTTER	1150X2400	1
2	W	WINDOW	UPVC SLIDING WINDOW	910X1350	6
3	D	DOOR	RCC DOOR FRAME WITH READYMADE SHUTTER	1200X2100	1
4	D1	DOOR	RCC DOOR FRAME WITH READYMADE SHUTTER	910X2100	1
5	D2	DOOR	PVC SHUTTER WITH FRAME	750X2100	1
6	V	VENTILATOR	CEMENT JALI	910X600	1
7	G1	GRILL	M.S GRILL	600X1350	1

Plinth Area :
42.82 Sq.Mt. x 03 No's
Total Area : 128.46 Sq.Mt.



FOOTING DETAIL

TURNKEY DESIGN AND BUILD CONTRACTOR :-

STRUCTURAL CONSULTANT :

ARCHITECTS:

CLIENT:

TAMIL NADU SLUM CLEARANCE BOARD
NO.5, KAMARAJAR SALAI, CHENNAI - 600005

PROJECT:

CONSTRUCTION OF CONSTRUCTION OF (G+5)FLOORS 1152 TENEMENTS AT NUKKAMPALAYAM ROAD, PERUMBAKKAM VILLAGE, SHOLINGANALLAUR TALUK, UNDER GHTC - I

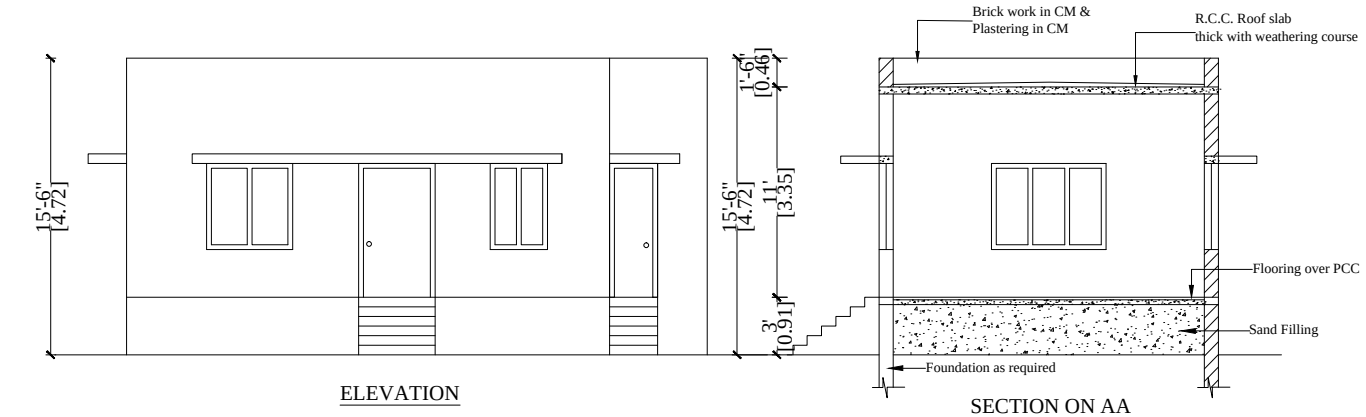
RATION SHOP

SIZE-A3 | SCALE: 1:100 | NOTE: ALL DIMENSIONS ARE IN MILLIMETER | REV. 00

DWG. NO.

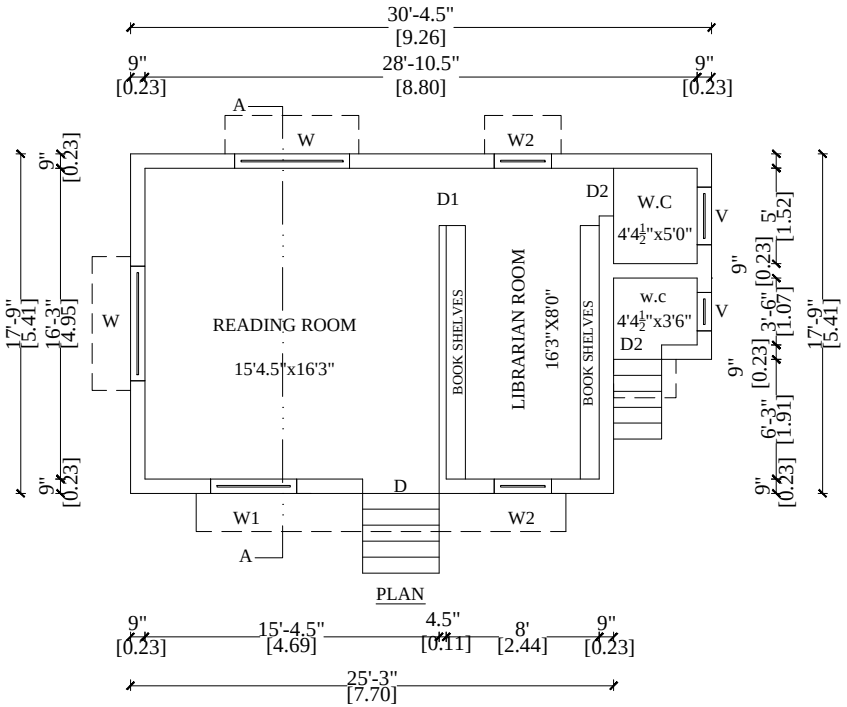
FILE LOC.

PLANNING ASST.	ASST. PLANNER
DEPUTY PLANNER	CHIEF ENGINEER



ELEVATION

SECTION ON AA



PLAN

SHEET NO - 04

TAMIL NADU
SLUM CLEARANCE BOARD

Proposed Type Design for the construction of Library at Perumbakkam scheme, Sholinganallur Taluk, Kancheepuram District, Chennai.

REFERENCE:

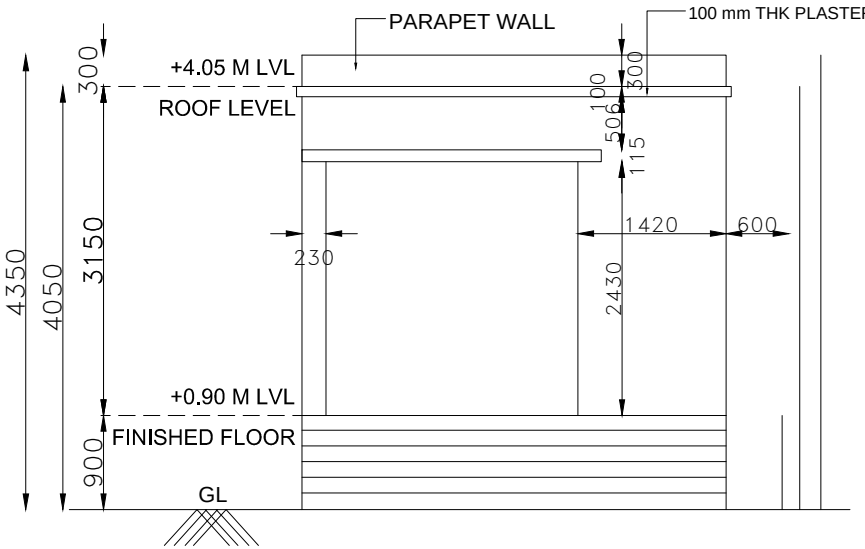
D	- Door	-	1.22 x 2.13(4'0"x7'0")
D1	- Door	-	0.91 x 2.13(3'0"x7'0")
D2	- Door	-	0.76 x 2.13(2'6"x7'0")
W	- Window	-	1.37 x 1.37(4'6"x4'6")
W1	- Window	-	0.91 x 1.07(3'0"x3'6")
V	- Ventilator	-	0.91 x 0.61(3'0"x2'0")

AREA DETAILS:

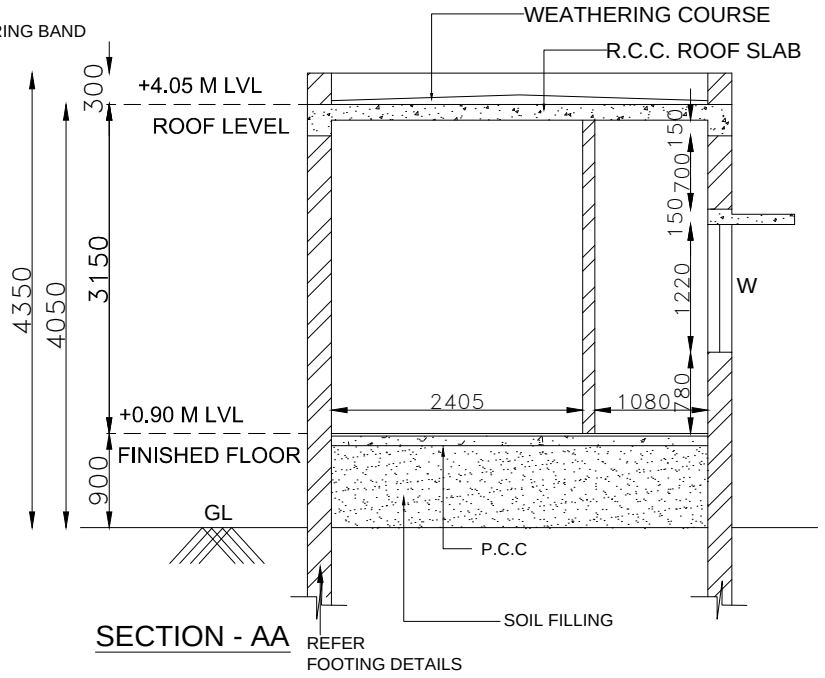
Plinth Area - 46.75 Sq.m
Extent - 112.63 Sq.m

SCALE - 1:100

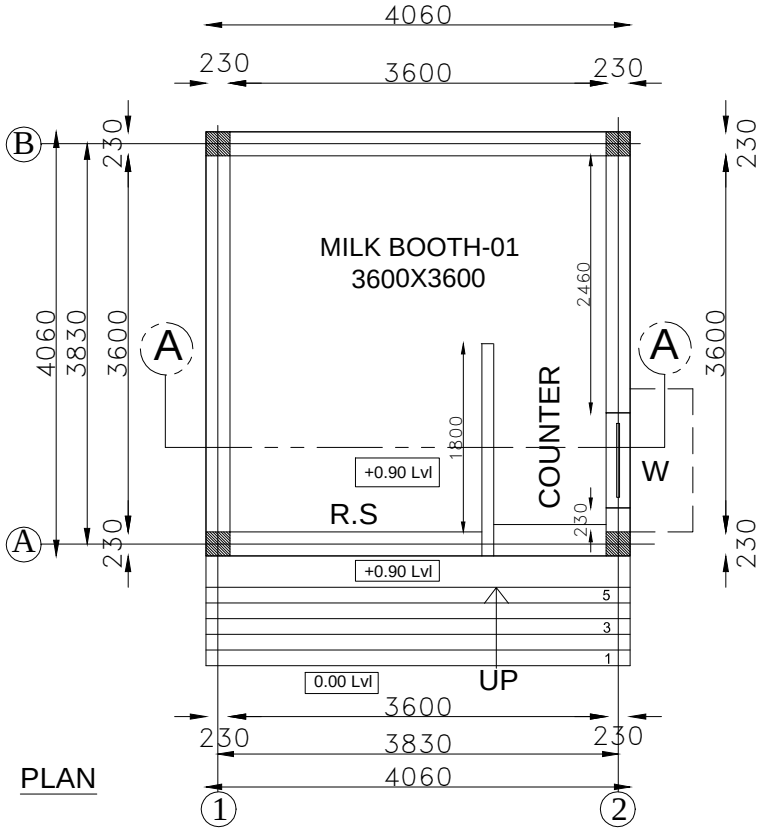
PLANNING ASST.	ASST.PLANNER
DEPUTY PLANNER	CHIEF ENGINEER



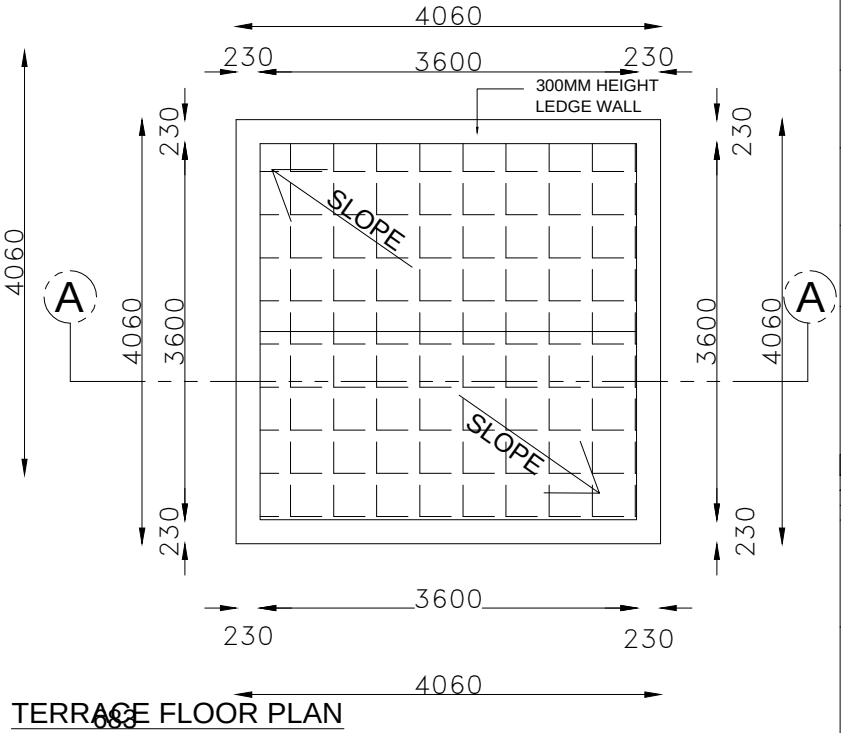
ELEVATION



SECTION - AA



PLAN



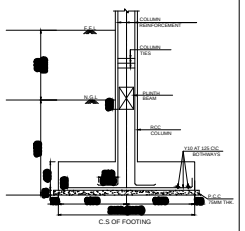
TERRACE FLOOR PLAN

SHEET NO-06/11

SCHEDULE OF JOINERY

S.NO	TYPE	DESCRIPTION		SIZE(MM)	NOS
1	RS	ROLLING SHUTTER	STEEL ROLLING SHUTTER	2400X2400	1
2	W	WINDOW	UPVC SLIDING WINDOW	910X1200	1

Plinth Area :
16.48 Sq.Mt. x 03 No's
Total Area : 49.44 Sq.Mt.



FOOTING DETAIL

TURNKEY DESIGN AND BUILD CONTRACTOR :-

STRUCTURAL CONSULTANT :

ARCHITECTS:

CLIENT:

TAMIL NADU SLUM CLEARANCE BOARD
NO.5, KAMARAJAR SALAI, CHENNAI – 600005

PROJECT:

CONSTRUCTION OF CONSTRUCTION OF (G+5)FLOORS 1152 TENEMENTS AT NUKKAMPALAYAM ROAD, PERUMBAKKAM VILLAGE, SHOLINGANALLAUR TALUK, UNDER GHTC - I

MILK BOOTH

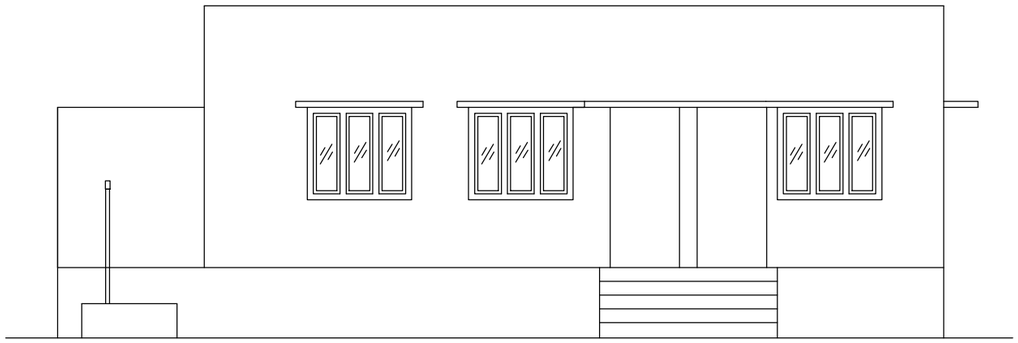
SIZE-A2 | SCALE- 1:100 | NOTE: ALL DIMENSIONS ARE IN MILLIMETER

DWG. NO. | REV. 00

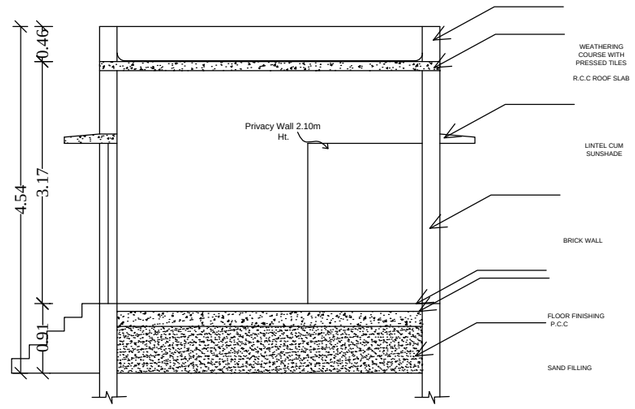
FILE LOC.

PLANNING ASST. | ASST. PLANNER

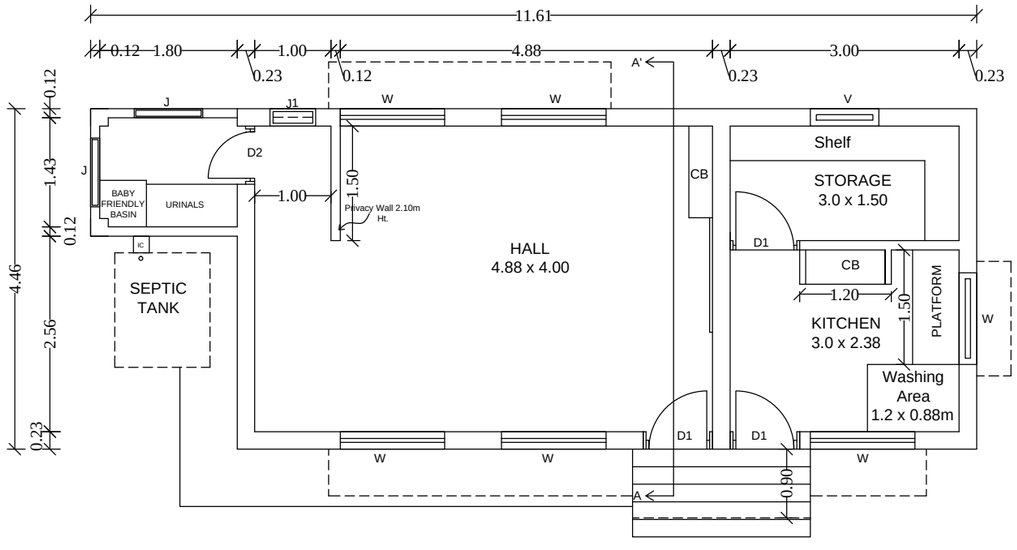
DEPUTY PLANNER | CHIEF ENGINEER



FRONT ELEVATION



SECTION ON - AA'



PLAN

TAMIL NADU SLUM CLEARANCE BOARD

PROPOSED TYPE DESIGN FOR THE CONSTRUCTION OF NOON MEAL CENTRE / ANGANWADI / ICDS AT VACANT LAND IN KEELKATHIRPUTHUR IN S.No. 3/3A2 & 237/3 OF KEELKATHIRPUHUR VILLAGE, KANCHEEPURAM TALUK AND KANCHEEPURAM DISTRICT.

PLINTH AREA / UNIT - **46.42 sq.m**

SCHEDULE OF JOINERIES

TYPE	DESCRIPTION	SIZE
D1	DOOR	0.91 x 1.98m
D2	DOOR	0.76 x 1.98m
W	WINDOW	1.22 x 1.22m
V	VENTILATOR	0.91 x 0.61m
J	JOLLY	0.91 x 0.61m
J1	JOLLY	0.61 x 0.61m

SCALE - 1:100

NOTE

1. THE TYPE DESIGN TO BE ADOPTED FOR ATHIPATTU
2. ALL DIMENSIONS ARE IN METRE.

PREPARED BY : L.POONGODI DATE : 30-09-09

PLANNING ASST.	ASST. PLANNER
DEPUTY PLANNER	CHIEF ENGINEER

2.6 LHP 6 Tripura

2.6.1 Location Map

Project Location/Site

Location of the project area is shown in **Annexure-1**. Current land uses of the proposed LHP site area: (a) Open Land., (b) A school building which is non-functional (c) an existing settlement, called "Harijan Basti" comprising of about 100 households, (d) two existing ponds.

Approximate area available for development of LHP is 26,802.35 sq. with following broad breakup:

Land Uses	Available Area (Sq.m)
Open Land + School Area	6335.49
Harijan Basti Land	11339.15
Land to be reclaimed by part filling up of ponds	9127.71
Total Area	**26802.35**

TITLE: LOCATION PLAN

DWG NO

NORTH





	SIGN.											
	INITIALS											
	REVISIONS											
	SIGN.											
	INITIALS											
	REVISIONS											
PO	SIGN.											
	INITIALS											
ISSUE		DRN	DSN	CHD	CV	EL	IC	ME		PE/PM	APPD	DATE (dd-mm-yyyy)
					CLEARED							

FOR APPROVAL

DO NOT SCALE

"P" (PRELIMINARY) ISSUES ARE NOT TO BE USED FOR CONSTRUCTION / FABRICATION BUT ARE ISSUED FOR LIMITED PURPOSES ONLY AS INDICATED IN THE SMALL BLOCK ABOVE THIS BLOCK.

CONSTRUCTION / FABRICATION WORK IS PERMITTED ON 'R' (RELEASED) ISSUES ONLY.

INFORMATION CONTAINED WITHIN 'HOLD' IS NOT RELEASED FOR CONSTUCTION / FABRICATION. FIELD MUST GET DESIGN OFFICE TO CLEAR 'HOLDS' IN TIME BEFORE PROCEEDING WITH ANY CONSTRUCTION / FABRICATION WORK RELATED TO 'HOLDS'.

Proprietary rights of the information contained herein belong to TCE. This information is intended to be used for the mentioned purpose/project only. In case of misuse of information and any claim arising thereof, cost and consequence will be on the party misusing the information.

FILE NAME :

LIGHT HOUSE PROJECT, UNDER THE GLOBAL HOUSING TECHNOLOGY CHALLENGE, INDIA
AGARTALA–TRIPURA

LOCATION PLAN

TATA CONSULTING ENGINEERS LIMITED

SCALE : 1:1000

DC & DISC : NCR

DWG NO.

ISSUE P0

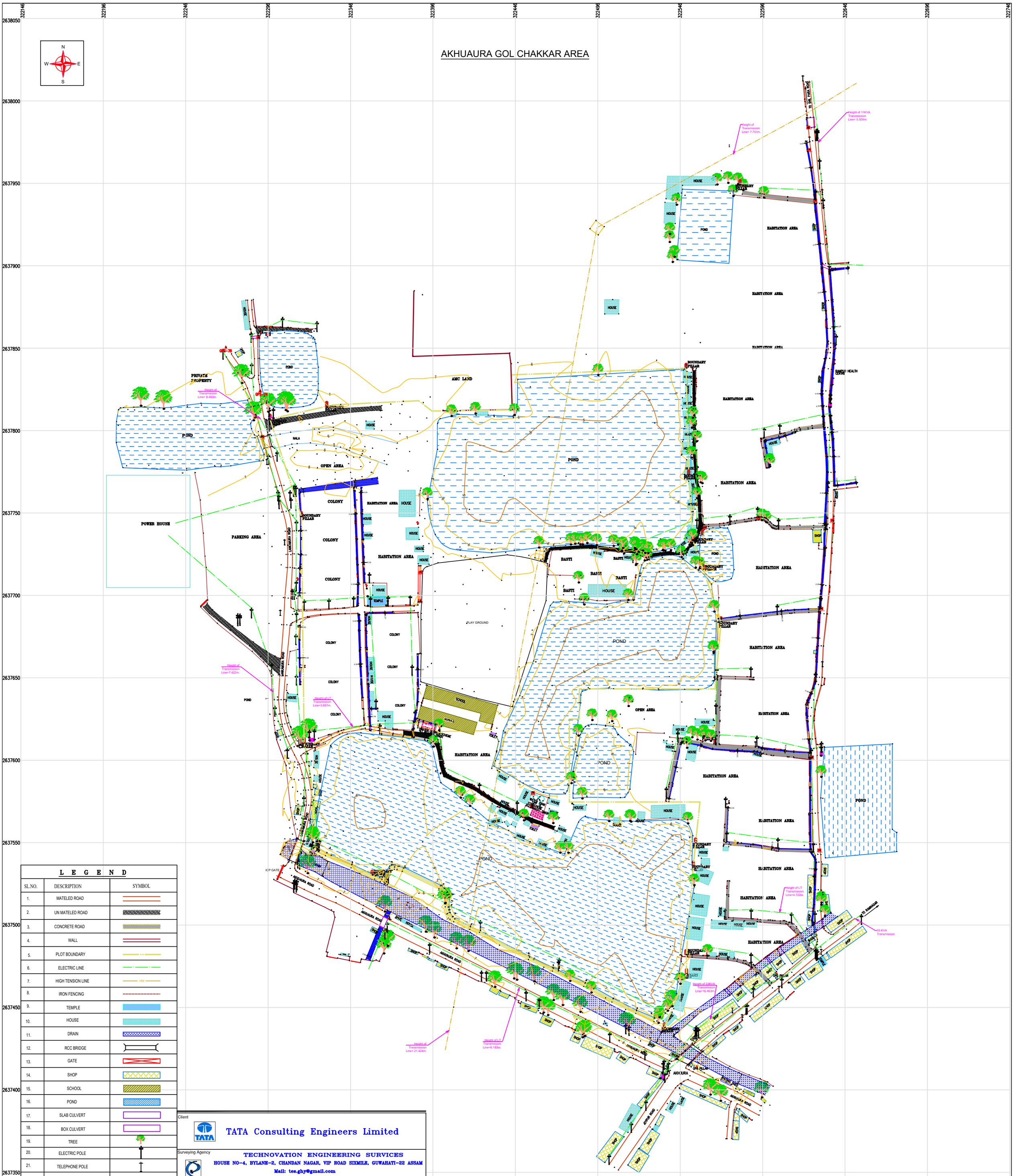
SIZE-A1

FILE NAME: F-091-Rev-R0.dwg

TCE FORM NO. 091 R0

2.6.2 Total Station Survey Map

AKHUAURA GOL CHAKKAR AREA



L E G E N D

SL.NO.	DESCRIPTION	SYMBOL
1.	MATELED ROAD	
2.	UN MATELED ROAD	
3.	CONCRETE ROAD	
4.	WALL	
5.	PLOT BOUNDARY	
6.	ELECTRIC LINE	
7.	HIGH TENSION LINE	HW
8.	IRON FENCING	
9.	TEMPLE	
10.	HOUSE	
11.	DRAIN	
12.	RCC BRIDGE	
13.	GATE	
14.	SHOP	
15.	SCHOOL	
16.	POND	
17.	SLAB CULVERT	
18.	BOX CULVERT	
19.	TREE	
20.	ELECTRIC POLE	
21.	TELEPHONE POLE	
22.	TRANSFORMER	
23.	TBM	
24.	GPS POINT	
25.	MAJOR CONTOUR	
26.	MINOR CONTOUR	
27.	STEP	

Client

TATA Consulting Engineers Limited

Surveying Agency

TECHNOVATION ENGINEERING SURVICES
HOUSE NO-4, BYLANE-2, CHANDAN NAGAR, VIP ROAD SIXMILE, GUWAHATI-22 ASSAM
Mail: tes.ghy@gmail.com
CONTACT NO- 986425188, 995718283, 9864035722

Title: AGARTALA SMART CITY PROJECT TOPOGRAPHICAL AND CONTOUR SURVEYFOR AKHUAURA GOL CHAKKAR AREA

Scale =1:750

Surveyed by	Drawn by	Checked by	Approved by	Date	Revision
B.Rajbongshi	D.Barman	D.Pathak	.....	05.09.18	Rev.00

DRG. NO.: TCE-AMC/Smart City/Project/TES/Survey/AGCA

Sheet No.: 01 OF 01

NOTES

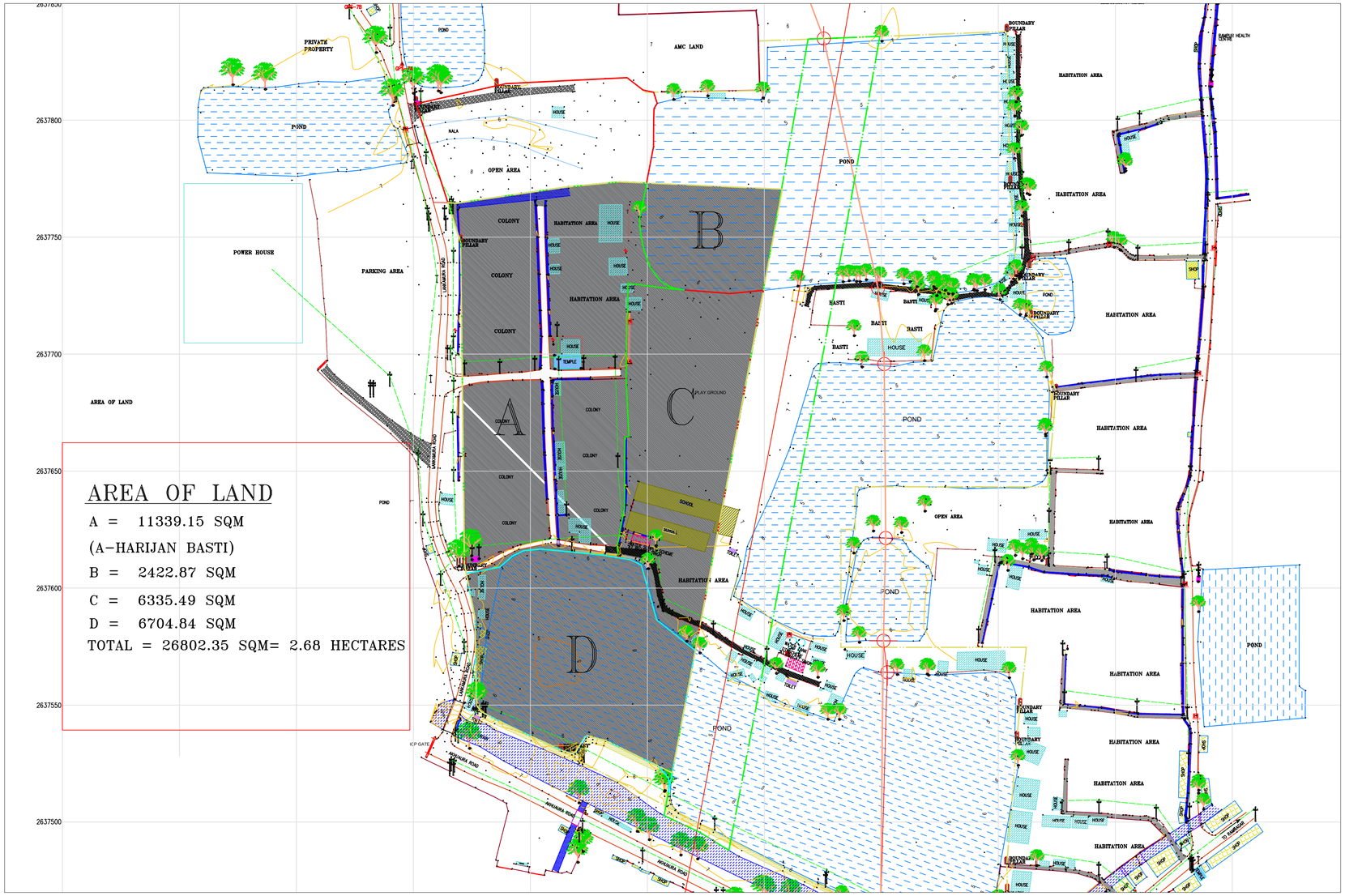
1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE STATED
2. SURVEY IS CARRIED OUT USING TOTAL STATION & HIGH PRECISION DGPS
3. PROJECTION: UTM, ZONE 46-N; DUTUM:-WGS-1984
4. GRIDS ARE IN UTM COORDINATES, INTERVAL=50M
5. PLOT AREA=74706.944 SQM.

LIST OF BENCH MARKS

CODE	NORTHING	EASTING	ELEVATION
GPS-07A	2637823.945	322291.144	7.665
GPS-07B	2637850.326	322270.325	7.785

DWG NO

TITLE: PROPOSED SITE DETAILS



AREA OF LAND

A = 11339.15 SQM

(A–HARIJAN BASTI)

B = 2422.87 SQM

C = 6335.49 SQM

D = 6704.84 SQM

TOTAL = 26802.35 SQM= 2.68 HECTARES

	SIGN.										
	INITIALS										
	REVISIONS										
	SIGN.										
	INITIALS										
	REVISIONS										
P0	SIGN.										
	INITIALS										
ISSUE		DRN	DSN	CHD	CV	EL	IC	ME	PE/PM	APPD	DATE (dd-mm-yyyy)
					CLEARED						

FOR APPROVAL

DO NOT SCALE

'P' (PRELIMINARY) ISSUES ARE NOT TO BE USED FOR CONSTRUCTION / FABRICATION BUT ARE ISSUED FOR LIMITED PURPOSES ONLY AS INDICATED IN THE SMALL BLOCK ABOVE THIS BLOCK.

CONSTRUCTION / FABRICATION WORK IS PERMITTED ON 'R' (RELEASED) ISSUES ONLY.

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Proprietary rights of the information contained herein belong to TCE. This information is intended to be used for the mentioned purpose/project only. In case of misuse of information and any claim arising thereof, cost and consequence will be on the party misusing the information.

FILE NAME :

LIGHT HOUSE PROJECT, UNDER THE GLOBAL HOUSING TECHNOLOGY CHALLENGE, INDIA
AGARTALA–TRIPURA

PROPOSED SITE DETAILS

TATA CONSULTING ENGINEERS LIMITED

SCALE : 1:1000

DC & DISC : NCR

DWG NO.

ISSUE P0

SIZE–A1

FILE NAME: F–091–Rev–R0.dwg

TCE FORM NO. 091 R0

2.6.3 Soil Testing Report

Job No: 421202

REPORT ON
GEOTECHNICAL INVESTIGATION WORK FOR
AGARTALA SMART CITY PROJECT, TRIPURA

(Highrise Building for Slum Dwellers, Akhaura)

Client:

M/S. TATA Consulting Engineers Limited,
Unit No.- NB 1502 & SB 1501, 15th Floor,
Empire Tower, Cloud City Campus, Village E
Kalwa Industrial Est, Thane Belapur Road, Airoli
Navi Mumbai – 400708
Maharashtra, India.

Foundation Consultants:

C. E. Testing Company Pvt. Limited
An ISO 9001, 14001 & OHSAS 18001 Cerified Company
NABL Accredited Laboratory
124A, N. S. C. Bose Road : Kolkata - 700 092
Phones : 2428-6221/6222/6223 Fax : (033) 2428-6220
Email : cetest@cetestindia.com

October – 2018

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2.	**FIELD INVESTIGATION**	
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3.	**LABORATORY TESTING**	**6**
4.	**SUB-SOIL CONDITIONS, STRATIFICATION & PROPERTIES**	**7**
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	Sub-Soil Stratifications	7
	Generalized Soil Profile	8
	Graphical Presentation	10
	Variation of “N” with Depth	10
5.	**DISCUSSION**	**11**
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	Use of R.C.Bored Pile	11
	Swelling Characteristics	16
	Chemical Tests	16
6.	**SUMMARY & CONCLUSIONS**	**17**
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REPORT ON
GEOTECHNICAL INVESTIGATION WORK FOR
AGARTALA SMART CITY PROJECT, TRIPURA

1. INTRODUCTION

Government of India plans to implement Smart City Programme to transform 100 Indian Cities to Smart Cities. **TATA Consulting Engineers Limited** have been appointed as Project Management Consultant to design, develop certain parts of Agartala, the capital city of Tripura under **Area based Development.** For layout plan and designing various foundation structures coming under this project, it was necessary to conduct a detailed Geotechnical Investigation work to obtain engineering properties of the underlying soil and **M/s. Tata Consulting Engineers Limited** appointed **M/s. C. E. Testing Company Pvt. Ltd.,** Kolkata as their Geotechnical Consultant.

This is a part of the whole project and deals with soil investigation for **Highrise Building for Slum Dwellers at Akhaura.**

The scope of the work comprises of sinking 02 nos. Boreholes.The bore holes were of 150 mm in diameter. It included advancing the boreholes by Shell and Auger equipment. The scope also included conducting Standard Penetration Tests, collecting disturbed samples at regular intervals for identification and logging purposes, collecting undisturbed tube samples at suitable intervals or at change of strata whichever is earlier and testing these in the laboratory.

Based on the above, this report presents the Bore Logs, Soil Profile, laboratory and field Test Results. On the basis of field tests and laboratory test results and their analysis thereof, the most suitable type of foundation is suggested. The field profile is sometimes changed in the light of laboratory test results.

The subsoil is of very poor to medium quality. It is characterized by filled up soil followed by a very soft to soft, clayey silt / silty clay layer. Below that, a medium, silty clay / clayey silt followed by a medium dense to dense silty sand layer was observed. A stiff to very stiff clayey silt layer appears afterwards. Underlying the above, a very dense, silty sand layer is encountered and that continued up to the termination depth of both the bore holes.

Considering the nature of the subsoil, field tests and laboratory tests, suitable foundation system is suggested. However this is discussed in details later.

Project : Geotechnical Investigation Work for Agartala Smart City Project, Tripura.			CETEST
Job No : 4212-02	Created by : JRC	Created on :	Sheet No:

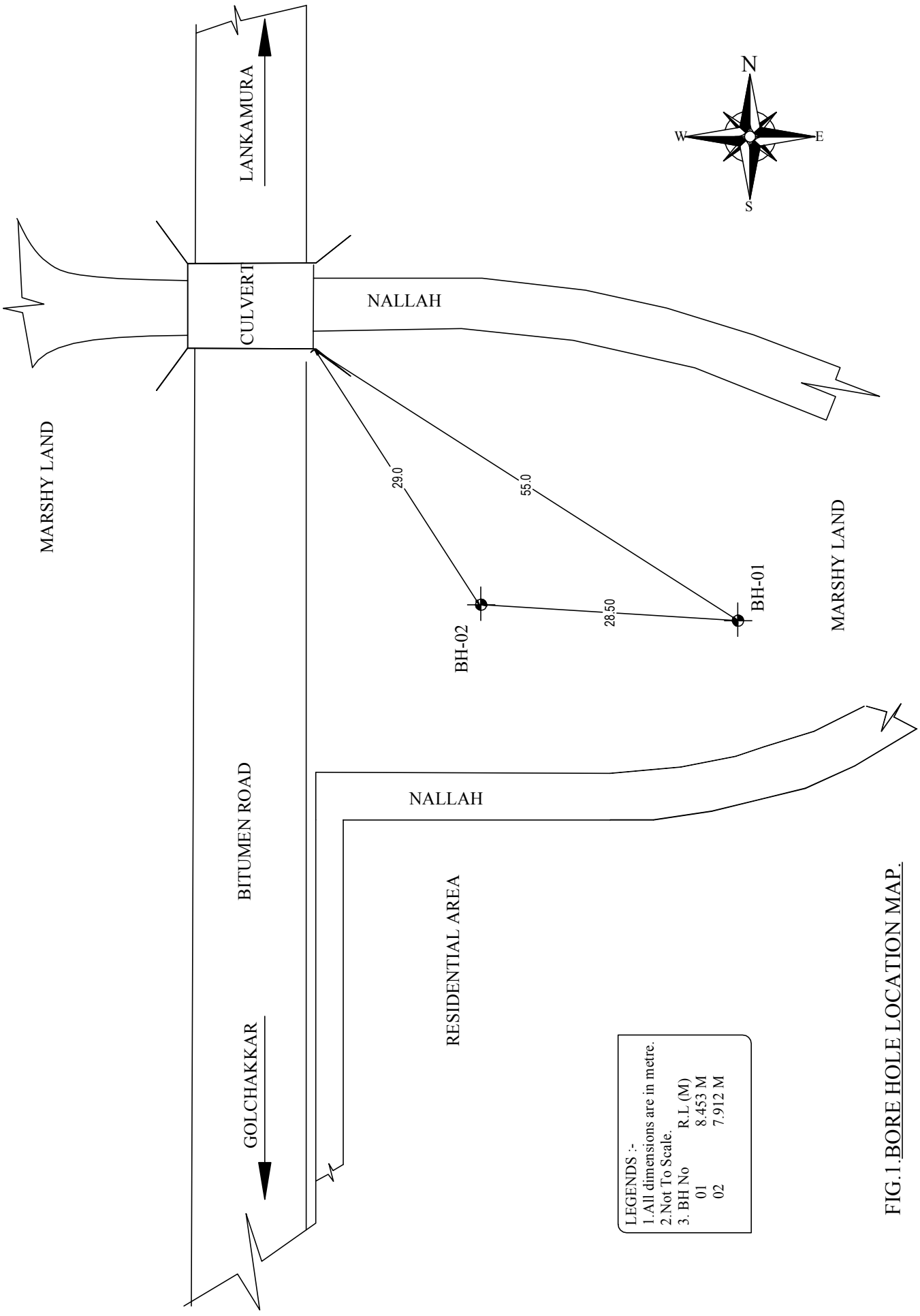


FIG.1.BORE HOLE LOCATION MAP.

2. FIELD INVESTIGATION

2.1. GENERAL:

In an attempt for optimization in the design of foundation for these proposed structures to be constructed at this site, Geotechnical Investigation was envisaged. The entire Investigation programme had been divided mainly into two parts, I) Field works & II) Laboratory tests.

I) Field works unfold the sub-surface deposit types and their characteristics and

II) Laboratory tests part would help determining the relevant physical and geotechnical properties of the sub-surface deposits leading to finalization of foundation depths of the structures and the bearing capacity with particular reference to the sub-surface types and their strength parameters and settlement potentials at the site.

A list of the bore holes with the Co-ordinates, R.L., terminating depth and standing water level below EGL are presented in a tabular form below:-

Bore Hole No.	Co-ordinate, (M)		R.L. (M)	Terminating Depth (m)	Standing Water Level (m)
	Easting	Northing			
BH-01	322352.444	2637779.793	8.453	31.63	2.30
BH-02	322323.929	2637777.575	7.912	30.00	1.80

2.2. BORING:

Boring was carried out by Shell and Auger method to sink nominal 150mm diameter bore holes to depths envisaged by using a mechanical winch. Undisturbed soil samples were collected at suitable intervals or at change of strata whichever is earlier by open drive sampling method since it was intended to ascertain the sub-soil characteristics.

2.3. SAMPLING:

Nominal 100 mm diameter undisturbed samples were recovered. The sampling equipment used consists of a two-tier assembly of sample tubes 450 mm in length fitted at its lower end. The sampling assembly was driven by means of a jarring link to its full length or as far downs as was found practicable. After withdrawal the ends of the tubes were sealed with wax and capped before onward transmission to the laboratory. At close intervals in depth disturbed samples were collected for identification and logging purpose. These were tagged and packed in polythene packets and transported to the laboratory.

2.4. STANDARD PENETRATION TESTS:

Standard Penetration Tests were conducted in the bore holes at intervals of 1.50M / 3.0M or at change of strata whichever is earlier in depth using a split spoon sampler. The split spoon sampler used is of a Standard design having an outer diameter of 50.8 mm and inner diameter of 35 mm, driving with a monkey weighing 63.5 kgs, falling freely through 75cms advances the spoon. A record of the number of blows required to penetrate every 7.5cms to a maximum depth of 45cms was made. The first 15cm of drive are considered to be seating drive and are neglected. The total blows required for third, fourth, fifth & sixth 7.50cm of penetration is counted and termed as penetration resistance "N". On completion of a test, the split spoon sampler was opened and soil specimens were preserved in polythene bags for logging purpose.

The borehole was sunk with winch. However, raising of hammer for SP Tests was done manually. Hence there will not be any inertia loss and the efficiency of hammer blows should be considered as 100%.

2.5. MEASUREMENT OF WATER TABLE:

Standing water level after 24 hours of removal of casing was noted and shown in the profile.

3. LABORATORY TESTING

For proper identification and classification of the sub-soil deposits and for deriving adequate information regarding its relevant physical and geotechnical properties at the site under investigation, the following laboratory tests were conducted on the soil samples collected from the exploratory bore holes:

1. ***Grain size analysis (Sieve as well as Hydrometer).***
2. ***Determination of Liquid Limit, Plastic Limit & Shrinkage Limit.***
3. ***Determination of Natural Moisture Content.***
4. ***Determination of Specific Gravity.***
5. ***Determination of Bulk & Dry Unit Weight.***
6. ***Strength determination by Triaxial Unconsolidated Undrained Test (UU).***
7. ***Strength determination by Vane Shear Test.***
8. ***Strength Determination of Unconfined Compression Test on "UDS" (UNCONFD).***
9. ***Strength Determination of Unconfined Compression Test on REMOULDED samples.***
10. ***One-dimensional Consolidation Test for determining settlement potentiality.***
11. ***Determination of Free Swell Index & Swelling Pressure.***
12. ***Chemical tests on soil samples to determine pH value, Sulphate, Chloride content, organic matter etc.***

Laboratory test results are presented in a tabular form in the Appendix. The results are self explanatory except that of consolidation tests. The compressibility for a pressure range has been separated into 2 components through the compression ratio. As a first step dial gauge reading is plotted against square root of time and by extrapolation dial reading at zero time, is obtained. The compression ratio is given as

$r = (d_i - d_s)/(d_i - d_f)$, where

d_i = Initial reading of dial before load application

d_s =Dial reading corresponding to theoretical zero time

d_f = Final dial reading after 24 hrs.

Now we write $m_{vc} = (1- r) \times m_v$

All the tests were conducted as per relevant Indian Standard Specifications.

4. SUBSOIL CONDITION, PROPERTIES AND STRATIFICATION

4.1. SUB-SOIL CONDITIONS:

The boring records showing the various soils met with are enclosed in the Appendix. These are prepared from field logs after proper modifications in the light of the laboratory test results and observation of disturbed and penetrometer soil samples. The results of the Standard Penetration Tests are given as 'N' values in these boring records. The sub-soil profiles (as obtained from field and Laboratory test results) across the bore holes are shown under Fig. 2 giving description, consistency and colour of each stratum. The "N" values are shown in the profile. The laboratory test results and the backup sheets are presented in the Appendix.

4.2. SUB-SOIL STRATIFICATIONS:

The subsoil is of very poor to medium quality. It is characterized by filled up soil followed by a very soft to soft, clayey silt / silty clay layer. Below that, a medium, silty clay / clayey silt followed by a medium dense to dense silty sand layer was observed. A stiff to very stiff clayey silt layer appears afterwards. Underlying the above, a very dense, silty sand layer is encountered and that continued up to the termination depth of both the bore holes. The layer wise description of each layer is presented below.

4.2.1. FILL:

Filled up soil consists of deep grey, silty clay with debris, garbage & brick bats. The average properties of this layer (which may not be truly representative of this layer) are presented below.

Bulk Density, gms/cc	1.74	Specific gravity	2.58
Dry Density, gms/cc	1.24		
Natural Water Content, %	40	**GRAIN SIZE**	
TRSH-UU:		Sand %	13
Cohesion kg/sqcm	0.20	Silt %	73
Friction angle °	0	Clay %	14

4.2.2. STRATUM - I:

The soil in this layer consists of very soft to soft, steel grey, clayey silt / silty clay with decomposed wood & organic matter. Average “N” value of this layer is 02. The “UDS” that could be collected from this layer show the following average properties.

Bulk Density, gms/cc	1.50	Specific gravity	2.53
Dry Density, gms/cc	0.80	Void ratio	1.157
Natural Water Content, %	87	Liquid Limit %	47
		Plastic Limit %	27
TRSH-UU:		Plasticity Index %	20
Cohesion kg/sqcm	0.13	Shrinkage Limit %	26
Friction angle °	0	**GRAIN SIZE**	
UNCONFINED "C"	0.08	Sand %	15
REMOULDED "C"	0.03	Silt %	70
SENSITIVITY	2.67	Clay %	15

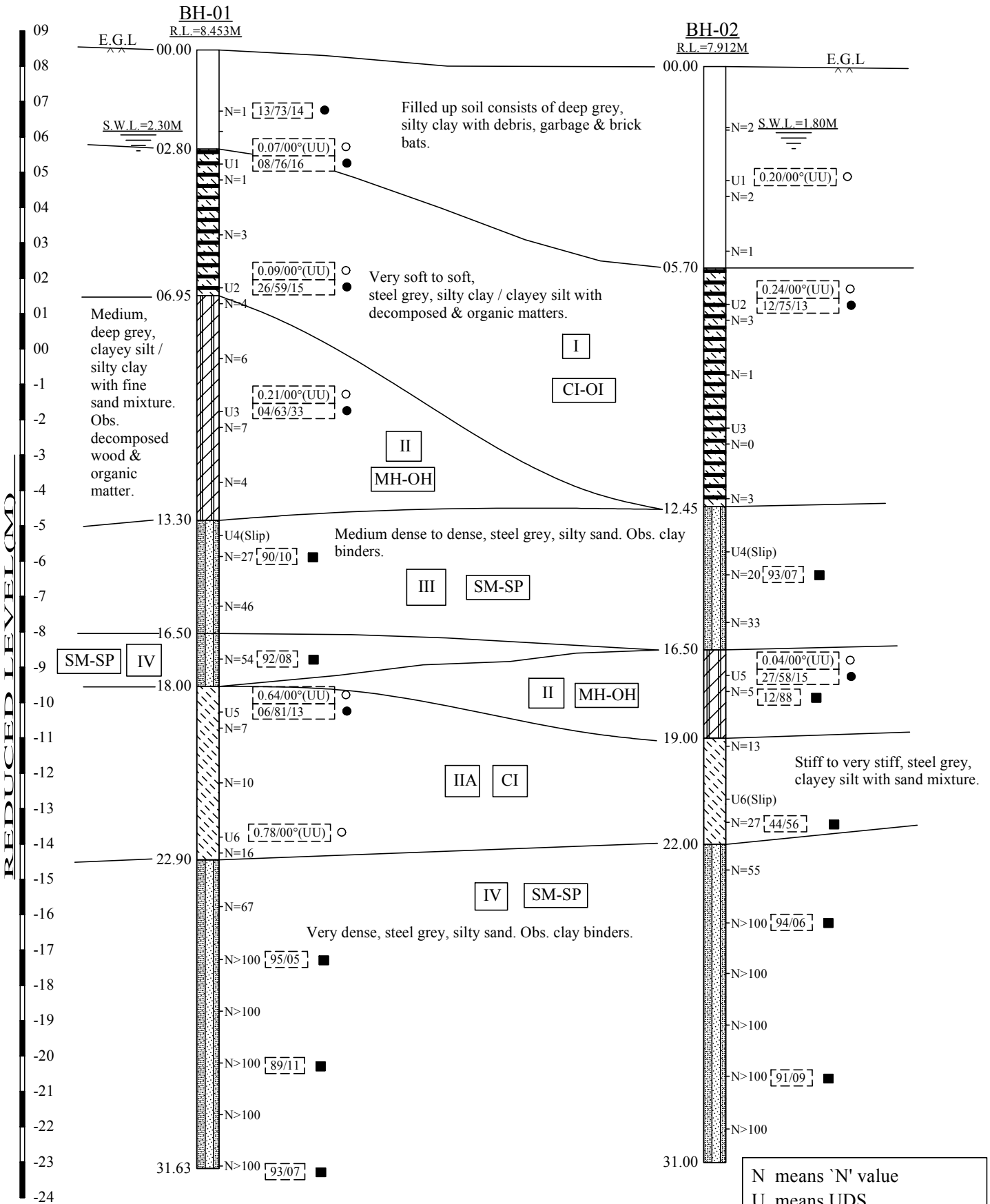


FIG.2.GENERALISED SOIL PROFILE.

4.2.3. STRATUM - II:

The soil in this layer consists of medium, deep grey, silty clay / clayey silt with fine sand mixture. Decomposed wood & organic matter have been observed in this layer. Average “N” value of this layer is 05. The “UDS” as well as SPT sample that could be collected from this layer show the following average properties.

Bulk Density, gms/cc	1.55	Liquid Limit %	57
Dry Density, gms/cc	0.90	Plastic Limit %	36
Natural Water Content, %	72	Plasticity Index %	21
Specific gravity	2.60	Shrinkage Limit %	28
TRSH-UU:		**GRAIN SIZE**	
Cohesion kg/sqcm	0.12	Sand %	14
Friction angle °	0	Silt %	50
		Clay %	26

4.2.4. STRATUM - IIA:

The soil in this layer consists of stiff to very stiff, steel grey, clayey silt with sand mixture. Average “N” value of this layer is 15. The “UDS” as well as SPT sample that could be collected from this layer show the following average properties.

Bulk Density, gms/cc	1.88	Specific gravity	2.64
Dry Density, gms/cc	1.40	Liquid Limit %	46
Natural Water Content, %	34	Plastic Limit %	24
TRSH-UU:		Plasticity Index %	22
Cohesion kg/sqcm	0.71	Shrinkage Limit %	15
Friction angle °	0	**GRAIN SIZE**	
UNCONFINED "C"	0.41	Sand %	25
REMOULDED "C"	0.27	Silt %	60
SENSITIVITY	1.52	Clay %	15

4.2.5. STRATUM - III:

The soil in this layer consists of medium dense to dense, steel grey, silty sand. Clay binders have been observed in this layer. Average corrected “N” value of this layer is 21. A few “SPT” samples that could be collected in this layer show the following average properties.

Specific gravity	2.62
GRAIN SIZE	
Sand %	91
(Silt + Clay) %	09

4.2.6. STRATUM - IV:

The soil in this layer consists of very dense, steel grey, silty sand. Clay binders have been observed in this layer. Average corrected “N” value of this layer is 40. A few “SPT” samples that could be collected in this layer show the following average properties.

Specific gravity	2.64
GRAIN SIZE	
Sand %	92
(Silt + Clay) %	08

4.3. GRAPHICAL PRESENTATION:

The Laboratory test results in summarised form are presented in Appendix. The backup sheets are presented there given in below.

i) Strength envelopes from Triaxial Tests.

ii) e-log p curves from consolidation tests.

iii) Grain size distribution curves for Sieve & Hydrometer tests.

The consolidation test results are analysed by numerical methods and only the final output in a tabular form is given. The m_{vc} indicates the time dependent component of m_v and c_v is the co-efficient of consolidation.

4.4. VARIATION OF "N" WITH DEPTH:

The field "N" values are presented in the bore logs. The corrected "N" values are given in a tabular form and also presented separately in Appendix. The "N" values are an important governing factor in calculation of bearing capacity. The strata wise corrected "N" values are given in the following table.

Stratum No.	Corrected "N" values.		
	Average	Maximum	Minimum
FILL	2	2	1
I	2	3	0
II	5	7	4
IIA	15	27	7
III	21	27	16
IV	40	44	28

5. DISCUSSION

5.1. GENERAL:

The subsoil is of very poor to medium quality. It is characterized by filled up soil followed by a very soft to soft, clayey silt / silty clay layer. Below that, a medium, silty clay / clayey silt followed by a medium dense to dense silty sand layer was observed. A stiff to very stiff clayey silt layer appears afterwards. Underlying the above, a very dense, silty sand layer is encountered and that continued up to the termination depth of both the bore holes.

Due to very poor subsoil condition, open foundation cannot be used. Considering the subsoil condition and the type of structures to be constructed at the present site, it is suggested to go for deep foundation in from of pile.

5.2. USE OF R. C. BORED PILE:

Bored cast-in-situ piles are preferred due to availability of construction agencies, ease of construction and less sound pollution. Such piles may be placed at 25M depth below EGL. Pile capacity is calculated based on average soil properties.

At first, the design strength parameters are determined. Thereafter, the pile capacity values are calculated. While determining the pile capacity, the following considerations are made.

a) Pile capacity is calculated using layer stratification around BH-02 location.
b) Cut off = 1.00 m.
c) Assumed Grade of Concrete = M25.
d) Diameter of pile used = 450, 500, 600 & 750 mm.

5.2.1. DESIGN STRENGTH PARAMETERS:

STRATUM – I:

Average “N” value in this layer = 02. So, estimated cohesion from N value = 0.25 kg/sqcm.

From laboratory TRSH-UU test result, cohesion = 0.13 kg/sqcm and $\Phi = 0°$

Considering the above use, C = 0.15 kg/sqcm and $\Phi = 0°$

Use Adhesion factor, $\alpha = 1.000$

STRATUM – II:

Average “N” value in this layer = 05. So, estimated cohesion from N value = 0.45 kg/sqcm.

From laboratory TRSH-UU test result, cohesion = 0.12 kg/sqcm and $\Phi = 0°$

Considering the above use, C = 0.25 kg/sqcm and $\Phi = 0°$

Use Adhesion factor, $\alpha = 1.000$

STRATUM – IIA:

Average “N” value in this layer = 15. So, estimated cohesion from N value = 0.85 kg/sqcm.

From laboratory TRSH-UU test result, cohesion = 0.71 kg/sqcm and $\Phi = 0°$

Considering the above use, C = 0.75 kg/sqcm and $\Phi = 0°$

Use Adhesion factor, $\alpha = 0.606$

STRATUM – III:

Design corrected "N" in this layer = 21, corresponding Relative Density (D_r) = 51.50 %

Fine particle is more than 5%,

Hence, Friction angle $\Phi_1 = 25+0.15 \times D_r = 25+0.15 \times 51.50 = 32.73° \approx 33°$

For bored cast-in-situ piles the soil get loosened during boring.

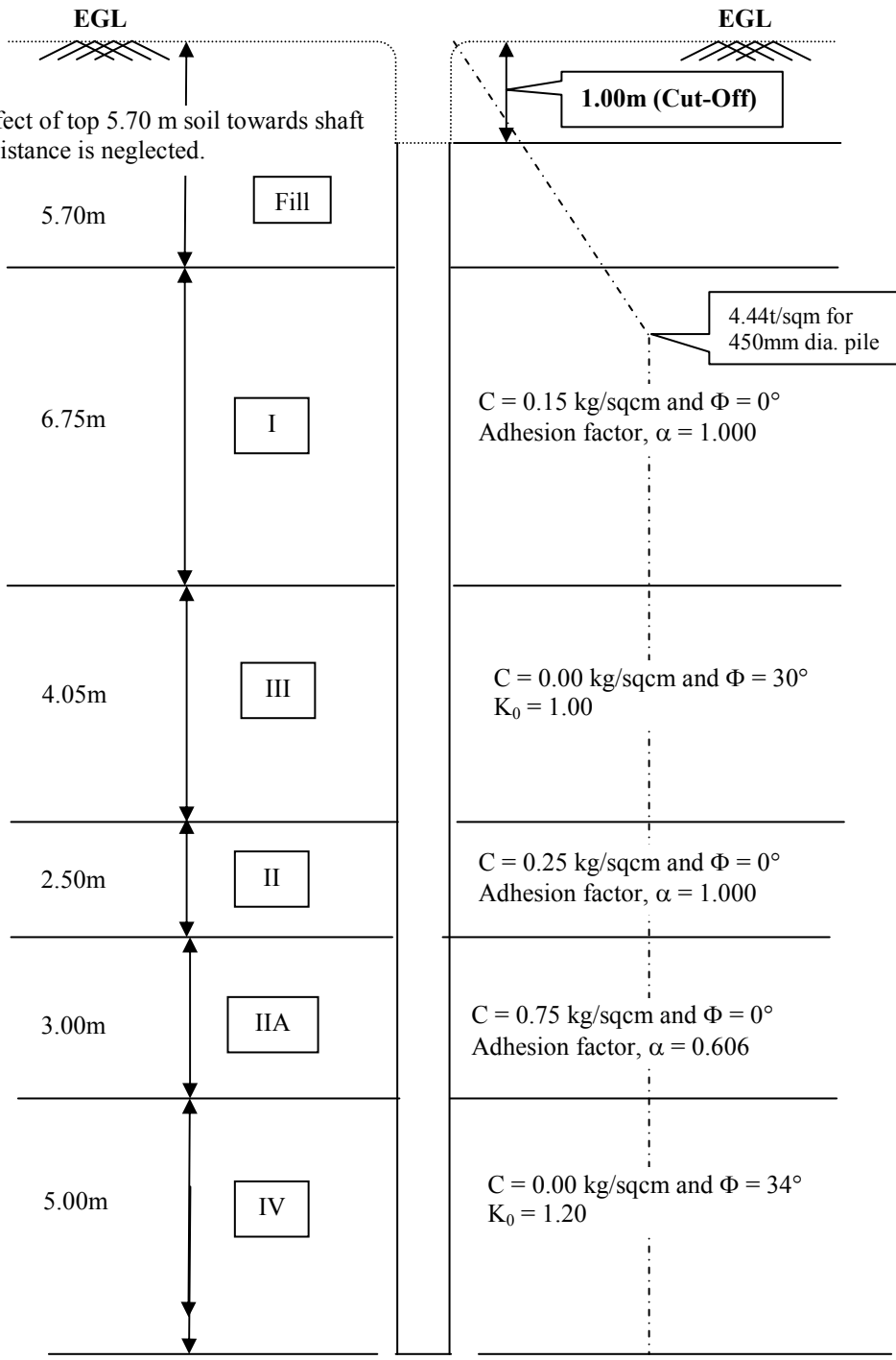
Poulos(1980) suggested that $\Phi = \Phi_1 - 3 = 33 - 3 = 30°$

Use, C = 0.00kg/sqcm & $\Phi = 30°$ and $K_o = 1.00$

STRATUM – IV:

Design corrected "N" in this layer = 40,

Use, C = 0.00kg/sqcm & $\Phi = 34°$ and $K_o = 1.20$ for this layer.



3. PILE FOUNDATION DESIGN MODEL WITH PR. DIA.

(Based on layer stratification around BH-02 location)

Not to scale

SAMPLE PILE CAPACITY CALCULATION

Bottom depth of Pile = 27.00 m below Existing ground level.

Cut-off Length = 1.00 m

Due to presence of Filled up soil at the top, the effect of 4.70m soil below cut off towards pile capacity is neglected.

Diameter of Pile = 450 mm | Critical depth = 15.00 D

FOS of Shaft Resistance = 2.50 | Maximum OVP = 4.44 t/sqm

FOS for End Bearing = 2.50

So, maximum Depth upto which pressure will increase = 6.75 m

Layer No.	Top Depth (M)	Bottom Depth (M)	Eff. Depth (M)	Cohesion (kg/sqcm)	Φ (Degree)	Adhesion Factor (α)	K_0	Eff. Density (gm/cc)	Mean Pressure (t/sqm)
FILL	1.00	5.70	4.70	--	--	--	--	0.65	2.18
I	5.70	12.45	6.75	0.15	0	1.000	1.00	0.70	4.38
III	12.45	16.50	4.05	0.00	30	1.000	1.00	0.90	4.44
II	16.50	19.00	2.50	0.25	0	1.000	1.00	0.60	4.44
IIA	19.00	22.00	3.00	0.75	0	0.606	1.00	0.90	4.44
IV	22.00	27.00	5.00	0.00	34	1.000	1.20	0.90	4.44

Layer No.	Eff. Depth (M)	Effective σ_z (t/sqm)	$f_{s1} = \alpha C$	$f_{s2} = K_0\sigma_z \tan\Phi$	$fs = f_{s1} + f_{s2}$ (t/sqm)	Ultimate Shaft Resistance (T)	Safe Shaft Resistance (T)
FILL	4.70	2.18	--	--	--	--	--
I	6.75	4.38	1.50	0.00	1.50	14.31	5.73
III	4.05	4.44	0.00	2.56	2.56	14.68	5.87
II	2.50	4.44	2.50	0.00	2.50	8.84	3.53
IIA	3.00	4.44	4.54	0.00	4.54	19.26	7.71
IV	5.00	4.44	0.00	3.59	3.59	25.40	10.16
	26.00					82.49	33.00

For End Bearing

Cohesion C= 0 kg/sqcm

Friction Angle = 34 °

Nq = 42.69

Eff. Ovp. Pressure=p(tip) 4.44 t/sqm

q(tip) =C.Nc+p(tip).Nq= 189.56 t/sqm

Ultimate End Bearing = 30.15 T

Safe End Bearing = 12.06 T

Safe Shaft Resistance= 33.00 T

So, Total Pile Capacity = 45.06 T

So, Recommended Pile Capacity = 40 T

With reference to the above design data, the vertical pile capacity is calculated. The recommended vertical pile capacity values (with a cut-off = 1.00m below EGL) are given below. A sample calculation sheet is enclosed separately.

Bottom depth of pile below EGL (M)	Pile Dia. (mm)	Recommended Vertical Pile Capacity (T)
25	450	35
	500	45
	600	65
	750	110
27	450	40
	500	50
	600	75
	750	120
30	450	45
	500	55
	600	85
	750	135

5.2.2. DETERMINATION OF LATERAL PILE CAPACITY:

Use C = 0.15 kg/sqcm for lateral pile capacity calculation.

Refer to IS : 2911 (Part I/Sec 2) - 2010, Appendix - C

Constant Factor, k_1 = 0.54 kg/cucm corresponding to Cohesion = 0.15 kg/sqcm

Now, K = (k_1/1.5) x (30/D) which is coming as 0.24 kg/cucm [D = Pile dia in cm]

Stiffness factor, R = $[EI/KD]^{1/4}$

Now, I = 0.20 x 10^6 cm^4 [for 450mm dia pile]

E = 5000 x $(f_{ck})^{0.5}$ = 5000 x $(25)^{0.5}$ = 25000 N/sqmm = 2.50 x 10^5 kg/sqcm

Hence, R = 261.27 cm

From Graph (Fig.4), L_f = 1.95 x R = 509.47 cm [Assuming Fixed Head Piles]

Pile Head deflection, Y = H x L_f^3 / 12EI = 2.1899mm for 1T load

So, for 5mm horizontal deflection , H = 2.28T, say 2.25T

Now, Moment = [H x L_f/2] = [1 x 5.09/2] = 2.55t-m per T of thrust

The Reduction Factor for computation of Maximum Moment in Pile, m = 0.70

So, the corrected actual moment, M = 2.55 x 0.70 = 1.78t-m per T of thrust.

5.3. SWELLING CHARACTERISTICS:

The swelling pressure and Free Swell Index tests have been performed on a few soil samples over the entire zone of investigation. The swelling pressure is 0.00kg/sqcm and Free Swell Index as found from the test ranges from 7.32% to 9.52%. Thus, the subsoil has low swelling characteristics. So, no problem with respect to the swelling of the subsoil is anticipated.

5.4. CHEMICAL TESTS:

Chemical tests were performed on few soil samples for determining the pH value, Sulphate, Chloride, and organic matter etc. The results are given in a tabular form below:

CHEMICAL TEST RESULTS ON SOIL SAMPLES:-

BH/Sample No.	Depth (m)	pH value	Sulphate as SO_3 (%)	Chloride as Cl (%)	Organic Matter (%)
01 / UDS-02	6.50	5.12	*B.D.L.	0.0070	0.9575
02 / UDS-02	6.50	5.00	*B.D.L.	0.0090	0.7629

*BDL = **B**elow **D**etection **L**imit (<0.050%)

It is seen that the values are within permissible limits (as per IS 456:2000). So no special cement will be required for foundation concrete. **Either Ordinary Portland cement or Portland slag cement or Portland Pozzolana cement can be used for the purpose.**

6. SUMMARY & CONCLUSIONS

Based on the field & laboratory tests and the foregoing discussion, the following are summarised.

1. The subsoil is of very poor to medium quality. It is characterized by filled up soil followed by a very soft to soft, clayey silt / silty clay layer. Below that, a medium, silty clay / clayey silt followed by a medium dense to dense silty sand layer was observed. A stiff to very stiff clayey silt layer appears afterwards. Underlying the above, a very dense, silty sand layer is encountered and that continued up to the termination depth of both the bore holes.

2. **Use of Deep Foundation:**
   a. Due to very poor subsoil condition, deep foundation in form of pile is recommended for the proposed structure.
   b. Bored cast in-situ piles are preferred due to availability of construction agencies, ease of construction and low level of noise pollution.
   c. The determination of pile capacity (vertical and lateral) for bored cast-in-situ piles is presented in the previous section. The recommended pile capacity values for different pile diameters are presented below. (Cut-off-1.00m, grade of concrete = M25).

Bottom depth of pile below EGL (M)	Pile Diameter (mm)	Recommended Pile Capacity			
		Vertical (T)	Lateral (T)	Moment (t-m per T of thrust)	Length of fixity (m)
25	450	35	2.25	1.78	5.09
	500	45	2.50	1.98	5.66
	600	65	3.00	2.38	6.79
	750	110	3.75	2.97	8.49
27	450	40	2.25	1.78	5.09
	500	50	2.50	1.98	5.66
	600	75	3.00	2.38	6.79
	750	120	3.75	2.97	8.49
30	450	45	2.25	1.78	5.09
	500	55	2.50	1.98	5.66
	600	85	3.00	2.38	6.79
	750	135	3.75	2.97	8.49

Note: Pile capacity shall be confirmed by conducting Initial Pile Load Test as per IS: 2911, Part-IV.

3. Chemical tests were performed on few soil samples to determine the pH value, Sulphate, Chloride, and organic matter. It is seen that the values are within permissible limits (as per IS 456). So no special cement will be required for foundation concrete**. Either Ordinary Portland Cement or Portland slag cement or Portland Pozzolana cement can be used for the purpose.**

For C. E. Testing Company Private Limited,

Prepared By	Checked By	Approved By
(B.BANERJEE)	(S. NATH)	(DR. M. NAYAK)

A P P E N D I C E S

SUBJECT	*SHEET NUMBER*
PART I: ALL FIELD TESTS RESULTS	**A1**
Bore Log Data Sheet	A2-A5
Correction for Standard Penetration Test Values	A6
Corrected “N” vs. Depth plot	A7
PART II: LABORATORY TEST RESULTS	**A8**
Laboratory Soil Test Results	A10-A11
Swelling Test Results	A12
PART III: CHARTS & GRAPHS	**A13**
Strength Curves	A14-A15
e-logp Curves	A16-A18
Grain Size Distribution Curves	A19–A23
PART IV: PHOTOGRAPHS	**A24-A25**

PART I: ALL FIELD TESTS RESULTS

Project : Geotechnical Investigation Work for Agartala Smart City Project, Tripura. CETEST

Job No : 421202 | Created by : S.NATH | Created on : 08/10/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.1

Co-ordinates E=322352.444 N=2637779.793

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	18	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	18
Vane (V)		Disturbed (DS)	19
		Water Sample (WS)	0

Commencement Date : 09/09/18
Completion Date : 11/09/18
Bore Hole Diameter : 150 mm.
Level Of Ground : 8.453 m.
Water Struck At :
Standing Water Level : 2.30 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=7.50cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of deep grey, silty clay with debris, garbage & brick bats.		0 0 0 0 1/0 1	DS-1	0.50
			DS-2	1.00
			SPT-1	1.50-1.95
			DS-3	2.50
2.80m.				
Very soft to soft, steel grey, silty clay. Obs. organic matters.		0 0 0 0 1/1 0	UDS-1	3.00-3.45
			SPT-2	3.45-3.90
			DS-4	4.50
		0 0 0 1 3/1 1	SPT-3	5.00-5.45
			DS-5	6.00
6.95m.			UDS-2	6.50-6.95
		0 0 1 0 4/1 2	SPT-4	6.95-7.40
			DS-6	8.00
Soft to medium, whitish grey, clayey silt / silty clay. with fine sand mixture.		1 1 1 1 6/2 2	SPT-5	8.50-8.95
			DS-7	9.50
			UDS-3	10.00-10.45
		1 1 1 2 7/2 2	SPT-6	10.45-10.90
			DS-8	11.50
		1 0 1 1 4/1 1	SPT-7	12.00-12.45
			DS-9	13.00
13.30m.			*UDS-4	13.50-13.95
Medium dense to dense, steel grey, silty sand. Obs. clay binders.		3 5 5 6 27/7 9	SPT-8	14.10-14.55
			DS-10	15.00
		4 6 9 10 46/12 15	SPT-9	15.50-15.95
16.50m.			DS-11	16.50
Very dense,steel grey, silty sand. Obs. clay binders.		5 8 12 12 54/13 17	SPT-10	17.00-17.45
18.00m.			DS-12	18.00
Medium / stiff to very stiff, steel grey, silty clay / clayey silt with fine sand mixture.		1 1 1 2 7/2 2	UDS-5	18.50-18.95
			SPT-11	18.95-19.40
20.00m.		7 12	DS-13	20.00

Project : Geotechnical Investigation Work for Agartala Smart City Project, Tripura.			CETEST
Job No : 421202	Created by : S.NATH	Created on : 08/10/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 1

Co-ordinates E=322352.444 N=2637779.793

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	18	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	18
		Disturbed (DS)	19
Vane (V)		Water Sample (WS)	0

Commencement Date : 09/09/18
Completion Date : 11/09/18
Bore Hole Diameter : 150 mm.
Level Of Ground : 8.453 m.
Water Struck At :
Standing Water Level : 2.30 m.

DESCRIPTION	SYMBOL	N-VALUE Each divn.=7.50cm.	SAMPLES Ref. No	SAMPLES Depth (m)
20.00m				
Medium / stiff to very stiff, steel grey, silty clay / clayey silt with fine sand mixture.		2 2 2 2 10/3 3	SPT-12	20.50-20.95
			DS-14	21.50
			UDS-06	22.00-22.45
22.90m		2 2 3 3 16/4 6	SPT-13	22.45-22.90
			DS-15	23.50
		4 8 11 16 67/19 21	SPT-14	24.00-24.45
			DS-16	25.00
		8 11 19 23 >100/27 32	SPT-15	25.50-25.95
			DS-17	26.50
Very dense, steel grey, silty sand. Obs. clay binders.		10 16 20 35 >100/57 7.0 cm Pentn.	SPT-16	27.00-27.37
			DS-18	28.00
		14 24 39 >100/52	SPT-17	28.50-28.80
			DS-19	29.50
		22 35 >100/62 7.0 cm Pentn.	SPT-18	30.00-30.22
			DS-20	31.00
31.63m		36 >100/53 5.5 cm Pentn.	SPT-19	31.50-31.63

N.B. – '*' means sample could not be recovered.

Project : Geotechnical Investigation Work for Agartala Smart City Project, Tripura.			CETEST
Job No : 421202	Created by : S.NATH	Created on : 08/10/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.2

Co-ordinates E=322323.929 N=2637777.575

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	18	Undisturbed (UDS)	6
Cone (Pc)		Penetrometer (SPT)	18
Vane (V)		Disturbed (DS)	20
		Water Sample (WS)	0

Commencement Date : 12/09/18
Completion Date : 14/09/18
Bore Hole Diameter : 150 mm.
Level Of Ground : 7.912 m.
Water Struck At :
Standing Water Level : 1.8 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=7.50cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
			DS-1	0.50
			DS-2	1.00
		1 0 0 1 2/0 1	SPT-1	1.50-1.95
Filled up soil consists of deep grey, silty clay with debris, garbage & brick bats.			DS-3	2.50
			UDS-1	3.00-3.45
		0 0 0 1 2/0 1	SPT-2	3.45-3.90
			DS-4	4.50
		0 0 0 0 1/1 0	SPT-3	5.00-5.45
5.70m.				
Deep grey, silty clay. Obs.organic matters.			DS-5	6.00
6.50m.				
			UDS-2	6.50-6.95
		1 0 1 0 3/1 1	SPT-4	6.95-7.40
			DS-6	8.00
		0 0 0 0 1/0 1	SPT-5	8.50-8.95
Soft to very soft, steel grey, silty clay.			DS-7	9.50
			UDS-3	10.00-10.45
		0 0 0 0 0/0 0	SPT-6	10.45-10.90
			DS-8	11.50
12.45m.		0 0 1 0 3/1 1	SPT-7	12.00-12.45
			DS-9	13.00
			*UDS-4	13.50-13.95
Medium dense to dense, steel grey, silty sand. Obs. clay binders.		2 3 4 4 20/5 7	SPT-8	14.15-14.60
			DS-10	15.00
		4 4 6 7 33/9 11	SPT-9	15.50-15.95
16.50m.			DS-11	16.50
			UDS-5	17.00-17.45
Medium, steel grey, silty clay. Obs. decomposed wood.		1 1 1 1 5/1 2	SPT-10	17.45-17.90
			DS-12	18.50
19.00m.		2 2 3 3 13/3 4	SPT-11	19.00-19.45
Stiff to very stiff, brownish grey, clayey silt with sand mixture.				
20.00m.			DS-13	20.00

BH-2/Sheet-1

Project : Geotechnical Investigation Work for Agartala Smart City Project, Tripura. CETEST

Job No : 421202 | Created by : S.NATH | Created on : 08/10/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.2

Co-ordinates E=322323.929 N=2637777.575

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	18	Undisturbed (UDS)	6
Cone (Pc)		Penetrometer (SPT)	18
Vane (V)		Disturbed (DS)	20
		Water Sample (WS)	0

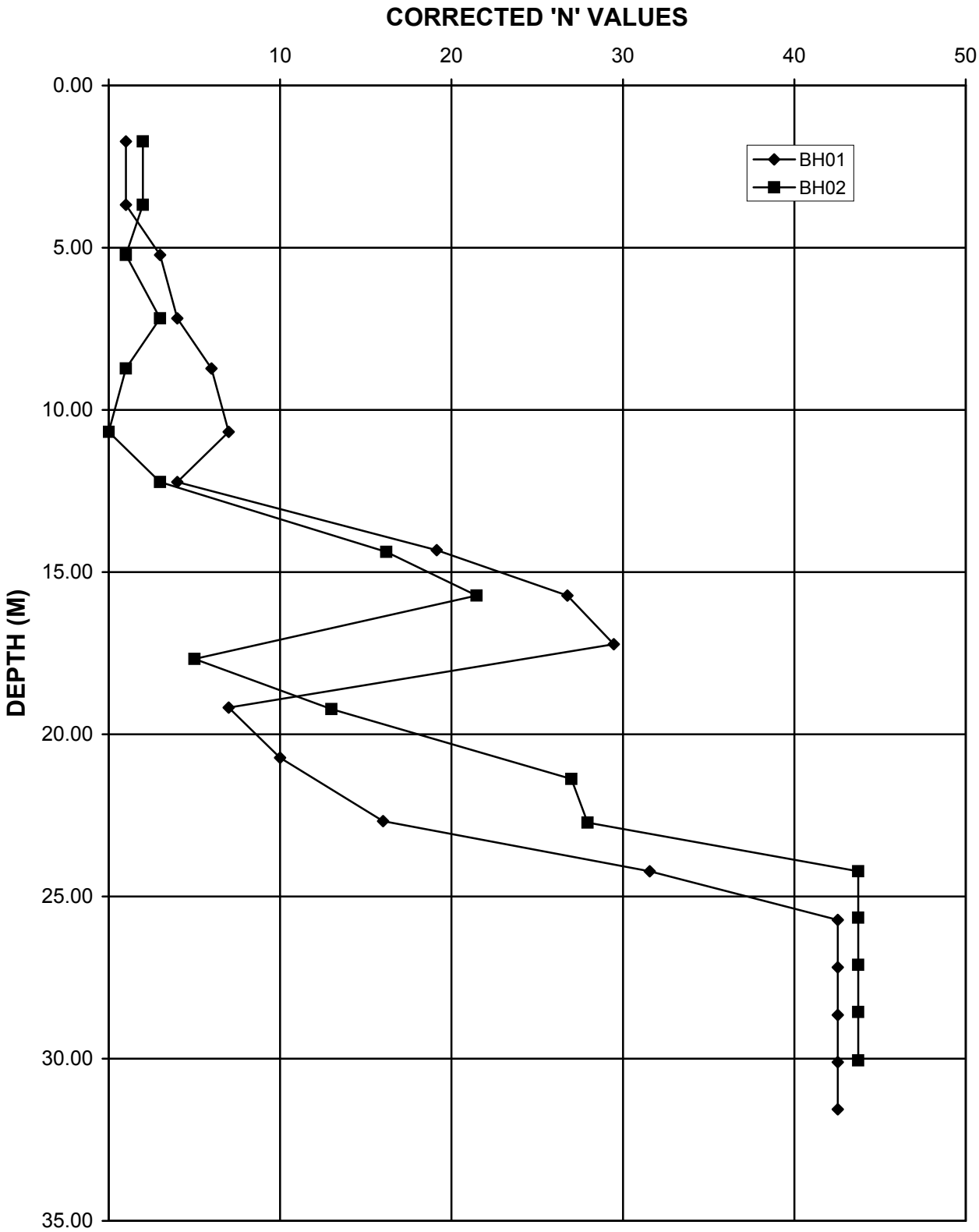
Commencement Date : 12/09/18
Completion Date : 14/09/18
Bore Hole Diameter : 150 mm.
Level Of Ground : 7.912 m.
Water Struck At :
Standing Water Level : 1.8 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=7.50cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
20.00m.				
Stiff to very stiff, brownish grey, clayey silt with sand mixture.		3 3 4 5 27/7 11	*UDS-6	20.50-20.95
			SPT-12	21.15-21.60
22.00m.			DS-14	22.00
		5 6 8 12 55/16 19	SPT-13	22.50-22.95
			DS-15	23.50
		8 9 14 19 >100/27 44	SPT-14	24.00-24.45
			DS-16	25.00
		11 23 35 >100/53	SPT-15	25.50-25.80
Very dense, steel grey, silty sand. Obs. clay binders.			DS-17	26.50
		17 39 >100/58 7.0 cm Pentn.	SPT-16	27.00-27.22
			DS-18	28.00
		25 >100/56 4.5 cm Pentn.	SPT-17	28.50-28.62
			DS-19	29.50
30.00m.		42 >100/52 2.5 cm Pentn.	SPT-18	30.00-30.10

N.B. - '*' means sample could not be recovered.

CORRECTION FOR STANDARD PENETRATION TEST VALUES

Bore Hole No:	Starting Depth (M)	Ending Depth (M)	Average Depth (M)	Field 'N' Values	Cor. 'N' for Ovp. & Dilatancy (if reqd)	Reduced Level (M)	Stratum
BH01	1.50	1.95	1.73	1	01	6.73	Fill
BH01	3.45	3.90	3.68	1	01	4.78	I
BH01	5.00	5.45	5.23	3	03	3.23	I
BH01	6.95	7.40	7.18	4	04	1.28	II
BH01	8.50	8.95	8.73	6	06	-0.27	II
BH01	10.45	10.90	10.68	7	07	-2.22	II
BH01	12.00	12.45	12.23	4	04	-3.77	II
BH01	14.10	14.55	14.33	27	19	-5.87	III
BH01	15.50	15.95	15.73	46	27	-7.27	III
BH01	17.00	17.45	17.23	54	29	-8.77	IV
BH01	18.95	19.40	19.18	7	07	-10.72	IIA
BH01	20.50	20.95	20.73	10	10	-12.27	IIA
BH01	22.45	22.90	22.68	16	16	-14.23	IIA
BH01	24.00	24.45	24.23	67	32	-15.77	IV
BH01	25.50	25.95	25.73	>100	43	-17.27	IV
BH01	27.00	27.37	27.19	>100	43	-18.73	IV
BH01	28.50	28.80	28.65	>100	43	-20.20	IV
BH01	30.00	30.22	30.11	>100	43	-21.66	IV
BH01	31.50	31.63	31.57	>100	43	-23.11	IV
BH02	1.50	1.95	1.73	2	02	6.19	Fill
BH02	3.45	3.90	3.68	2	02	4.24	Fill
BH02	5.00	5.45	5.23	1	01	2.69	Fill
BH02	6.95	7.40	7.18	3	03	0.74	I
BH02	8.50	8.95	8.73	1	01	-0.81	I
BH02	10.45	10.90	10.68	0	00	-2.76	I
BH02	12.00	12.45	12.23	3	03	-4.31	I
BH02	14.15	14.60	14.38	20	16	-6.46	III
BH02	15.50	15.95	15.73	33	21	-7.81	III
BH02	17.45	17.90	17.68	5	05	-9.76	II
BH02	19.00	19.45	19.23	13	13	-11.31	IIA
BH02	21.15	21.60	21.38	27	27	-13.46	IIA
BH02	22.50	22.95	22.73	55	28	-14.81	IV
BH02	24.00	24.45	24.23	>100	44	-16.31	IV
BH02	25.50	25.80	25.65	>100	44	-17.74	IV
BH02	27.00	27.22	27.11	>100	44	-19.20	IV
BH02	28.50	28.62	28.56	>100	44	-20.65	IV
BH02	30.00	30.10	30.05	>100	44	-22.14	IV



CORRECTED 'N' Vs DEPTH PLOT

PART II: LABORATORY TEST RESULTS

CETEST Engineering Consultants
An ISO 9001, 14001 & OHSAS 18001 Certified Company

C. E. Testing Company Pvt. Ltd.
(AN NABL ACCREDITED TESTING LABORATORY AS PER ISO/IEC 17025)
Sardarpara, Brahmapur,Kolkata-700 096,Tel: (033) 2410 5085/9813
E-mail: cetest.lab@gmail.com • Web: www.cetestindia.com
CIN: U74920WB1988PTC045778

Certificate No : TC-6840

Format No: CET/FM/42

TEST REPORT

TEST REPORT NO : 421202 DATE: 13/10/2018

ULR: TC684018000000007P

Name and Address of Customer: TATA Consulting Engineers Limited,
Unit No.- NB 1502 & SB 1501, 15th Floor,
Empire Tower, Cloud City Campus, Village E
Kalwa Industrial Est, Thane Belapur Road, Airoli
Navi Mumbai – 400708, Maharashtra, India.

Customer Reference No : 421202

Customer Reference Date : 04/10/2018

Date of Sample Received at Lab : 29/09/2018

Date of Starting of Test : 04/10/2018

Date of Completion of Test : 11/10/2018

Sample ID Nos : 421202/BH-01/SPT-01 to 421202/BH-02/SPT-17

Please refer the page no. A10 of A25 to A12 of A25 of the Report for the following:

1. Sample Description
2. Test methods used
3. Test results

Further to note that the test parameters are mentioned at the header of test result table.

* The report related to the particular sample(s) tested under stated condition.
* All tests are based as per IS/ASTM specifications
* Any discrepancy in this report should be brought to the notice within 15 (fifteen) days from the date of certificate
* Full/Partial use of this test results could not be done without the written permission of authorized signatory.

Bore	Sample	Depth	Sample Description	Bulk	Dry	Spec.	Nat.	Void	Strength Test Results				Atter. Limits			IS	Grain Size				Test
Hole	Number	M		Dens.	Dens.	Grav.	Mois.	Ratio	Pc/Pn	Shear	Cohesn	Frictn	LL	PL	SL	Classifi	Gravl	Sand	Silt	Clay	Method
				gms/cc	gms/cc		%		kg/sqcm	kg/sqcm	kg/sqcm	Deg.	%	%	%	cation	%	%	%	%	
BH01	SPT01	1.50	Brownish grey clayey silt with traces of sand mixture.			2.51												13	73	14	**See the Note
BH01	UDS01	3.00	Deep grey clayey silt.	1.70	1.14	2.71	53 S	1.268	TRSH-UU		0.07	0	47	28	25	MI		8	76	16	Do
							50 T		3.0	0.085											
							50 C		2.0	0.067											
									1.0	0.046											
BH01	UDS02	6.50	Deep grey clayey silt with decomposed wood & organic matter.	1.30	0.56	2.30	113 S	0.888	TRSH-UU		0.09	0	47	29	26	MI		26	59	15	Do
							142 T		3.0	0.103											
							48 C		2.0	0.095											
									1.0	0.079											
BH01	UDS03	10.00	Deep grey clayey silt with traces of organic matter.	1.52	0.87	2.58	82 S		TRSH-UU		0.21	0	59	41	30	CH		4	63	33	Do
							74 T		3.0	0.260											
									2.0	0.202											
									1.0	0.162											
BH01	SPT08	14.10	Brownish grey silty sand.			2.62										SM-SP		90	10 (Silt+Clay)		Do
BH01	SPT10	17.00	Brownish grey silty sand.													SM-SP		92	8 (Silt+Clay)		Do
BH01	UDS05	18.50	Steel grey clayey silt.	1.86	1.38	2.62	36 S		TRSH-UU		0.64	0	47	25	16	CI		6	81	13	Do
							35 T		3.0	0.653											
									2.0	0.637											
									1.0	0.625											
									UNCONFD		0.41	0									
									0.0	0.418											
									0.0	0.411											
									0.0	0.401											
									REMOULD		0.27	0									
									0.0	0.278											
									0.0	0.259											
									0.0	0.273											
BH01	UDS06	22.00	Steel grey clayey silt with traces of sand mixture.	1.90	1.46	2.65	32 S		TRSH-UU		0.78	0	45	22	14	CI					Do
							30 T		3.0	0.791											
									2.0	0.778											
									1.0	0.771											
BH01	SPT15	25.50	Brownish grey silty sand.			2.63										SM-SP		95	5 (Silt+Clay)		Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH01	SPT17	28.50	Brownish grey silty sand.													SM-SP		89	11 (Silt+Clay)		Do
BH01	SPT19	31.50	Brownish grey silty sand.													SM-SP		93	7 (Silt+Clay)		Do
BH02	UDS01	3.00	Deep grey silty clay with traces of brick bats.	1.74	1.23	2.65	38 S		TRSH-UU		0.20	0									
							42 T		3.0	0.212											
									2.0	0.204											
									1.0	0.184											
BH02	UDS02	6.50	Steel grey clayey silt.	1.79	1.18	2.69	47 S	1.315	TRSH-UU		0.24	0	47	25	28	CI		12	75	13	Do
							52 T		3.0	0.248											
							50 C		2.0	0.237											
									1.0	0.235											
BH02	UDS03	10.00	Deep grey clayey silt with decay decomposed wood and organic matter.	1.22	0.47	2.40	130 S		VANE SHEAR TEST							CI-OI*					
							165 T		UNCONFD "c" = 0.08		kg/sqcm										
									REMOULD "c" = 0.03		kg/sqcm										
BH02	SPT08	14.15	Brownish grey silty sand.													SM-SP		93	7 (Silt+Clay)		Do
BH02	UDS05	17.00	Deep grey clayey silt. Obs. Decomposed wood.	1.58	0.96	2.61	66 S		TRSH-UU		0.04	0	54	31	25	MH-OH		27	58	15	Do
							64 T		3.0	0.042											
									2.0	0.034											
									1.0	0.033											
BH02	SPT10	17.45	Dark grey clayey silt with traces of sand mixture & organic matter.													MH-OH*		12	88 (Silt+Clay)		Do
BH02	SPT12	21.15	Brownish grey clayey silt with sand mixture.													CI*		44	56 (Silt+Clay)		Do
BH02	SPT14	24.10	Brownish grey silty sand.			2.64										SM-SP		94	6 (Silt+Clay)		Do
BH02	SPT17	28.50	Brownish grey silty sand.													SM-SP		91	9 (Silt+Clay)		Do

*** - Classification in this case is based on average layer properties**

SWELLING TEST RESULTS

Bore Hole No.	Sample No.	Depth (M)	Description	Free Swell Index, (%)	Swelling Pressure, (kg/sqcm)	PI (%)	Test Method
BH-01	UDS-01	3.00-3.45	Deep grey clayey silt.	9.52	0.00	19	*See the note
BH-01	UDS-02	6.50-6.95	Deep grey clayey silt with decomposed wood & organic matter.	9.09	0.00	18	Do
BH-01	UDS-03	10.00-10.45	Deep grey clayey silt with traces of organic matter.	7.69	--	18	Do
BH-01	UDS-05	18.50-18..95	Steel grey clayey silt.	7.32	--	22	Do
BH-02	UDS-02	6.50-6.95	Steel grey clayey silt.	7.32	0.00	22	Do
BH-02	UDS-05	17.00-17.45	Deep grey clayey silt. Obs. Decomposed wood.	8.33	--	23	Do

****Note: Test Methods**

Bulk Density & Dry Density: Ref. CET/SOP/01, Issue No. 01
Grain size analysis: IS 2720 (Part 4)
Liquid Limit & Plastic Limit: IS 2720 (Part 5)
Shrinkage Limit: IS 2720 (Part 6)
Unconfined Compressive Strength Test of Soil: IS 2720 (Part 10)
Consolidation Properties (Void Ratio): IS 2720 (Part 15)
Natural Moisture Content: IS 2720 (Part 2)
Specific Gravity: IS 2720 (Part 3).
Free Swell Index: IS 2720 (Part 40)
Swelling Pressure: IS 2720 (Part 41)
Triaxial Test (TRSH-UU): IS 2720 (Part 11)

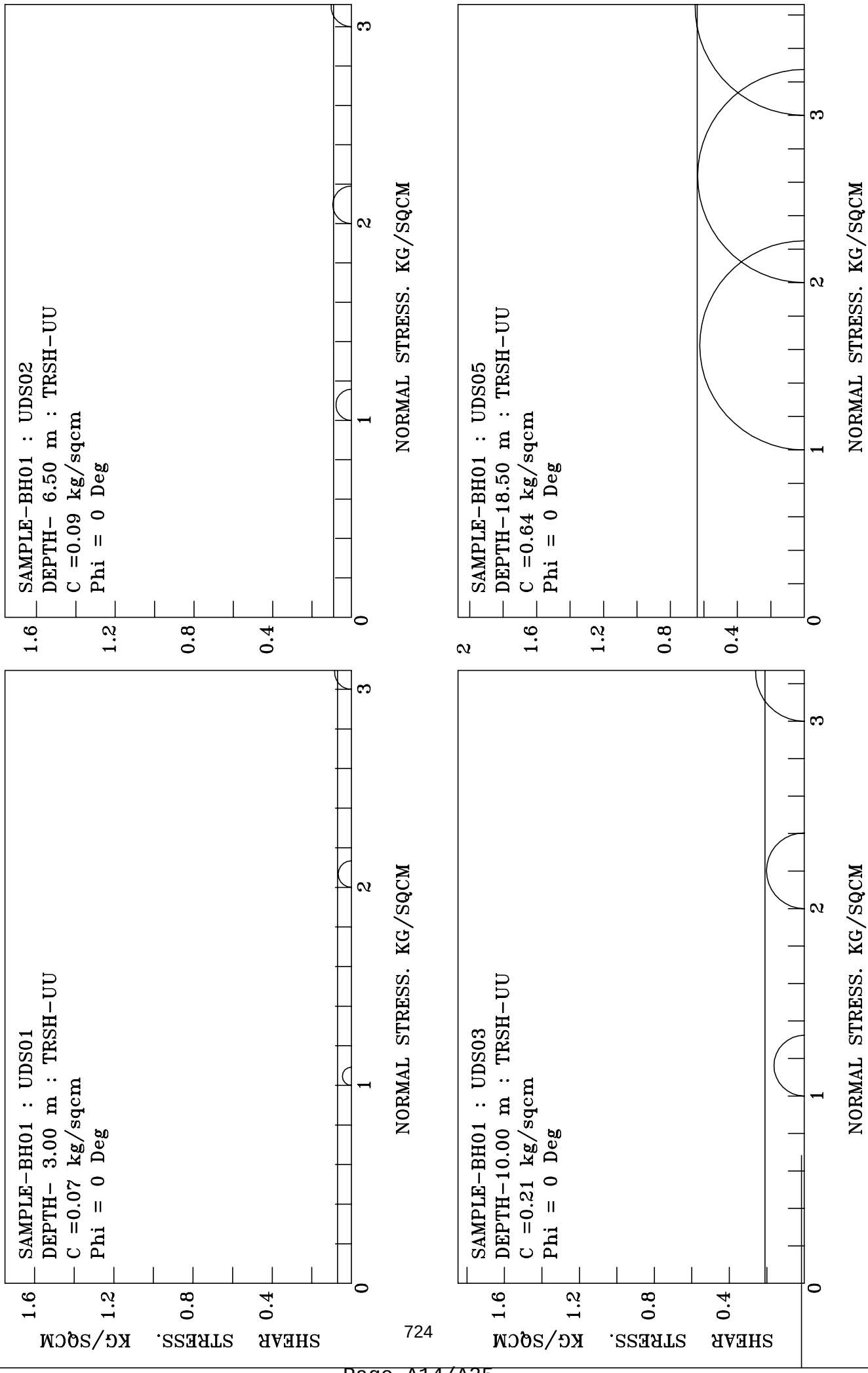
Vane Shear Test : Out of NABL scope

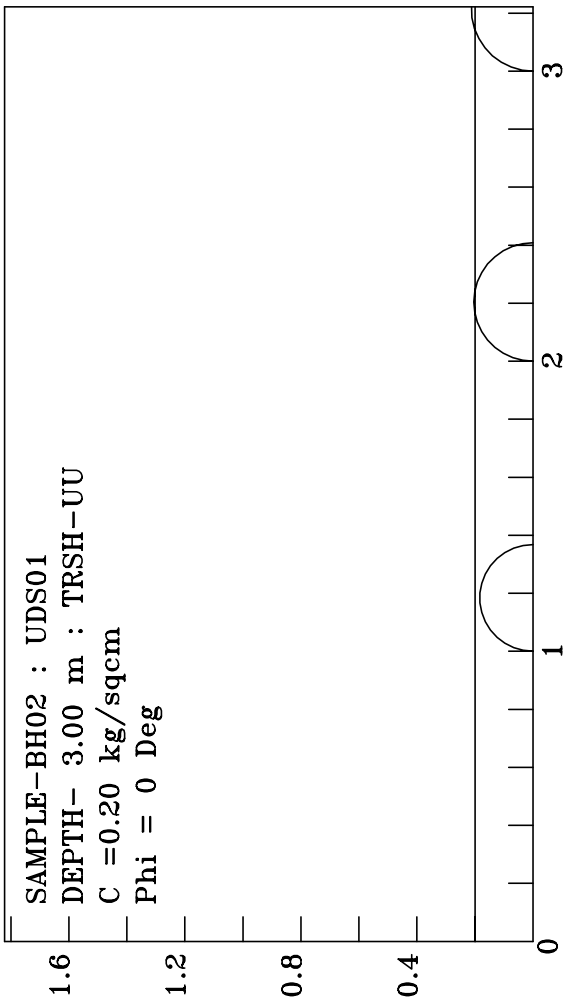
C.E.Testing Company Pvt. Ltd.

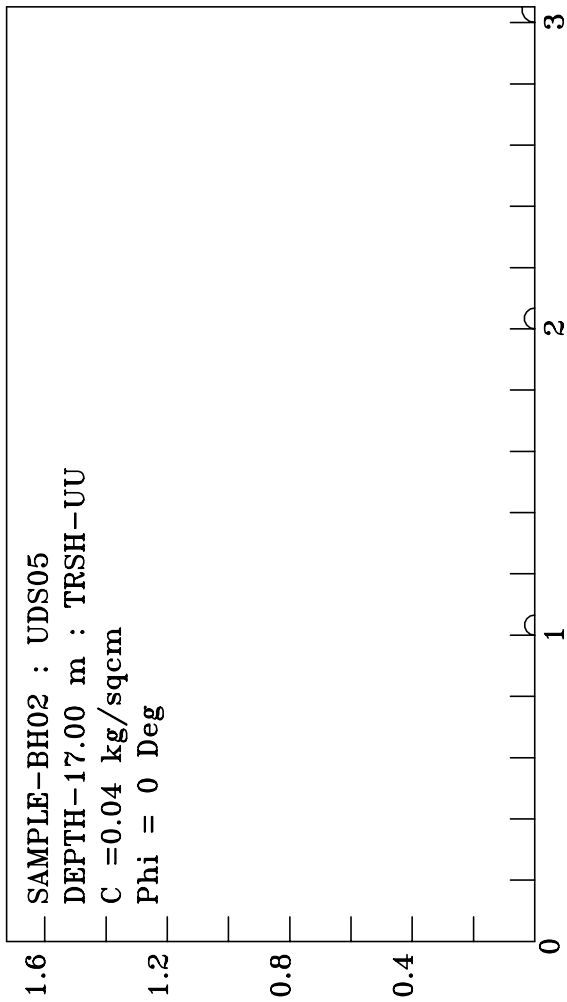
Prepared By
Indranil Chowdhury
(Indranil Chowdhury)
Dy. Technical Manager

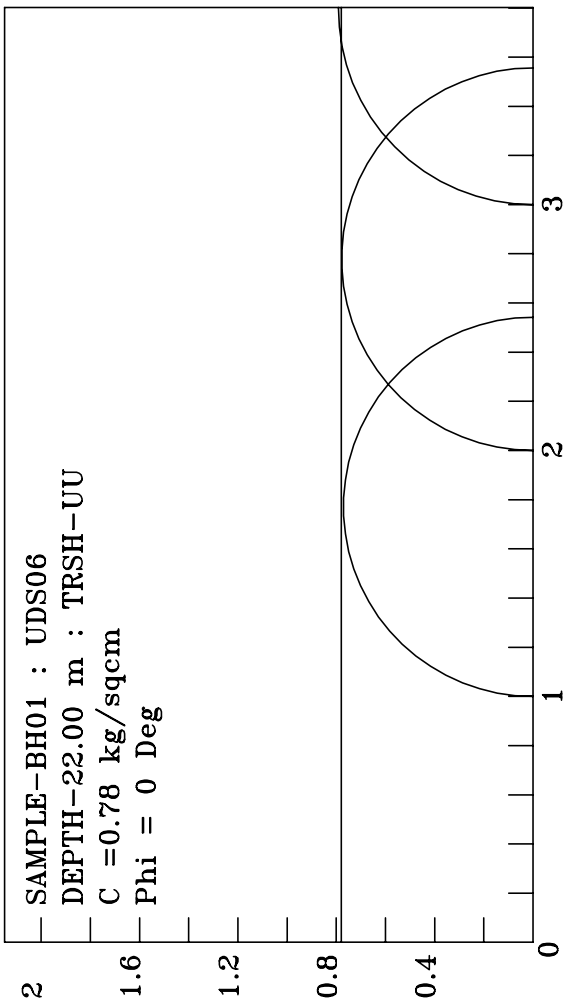
Checked & Approved By
Sudip Nath
Technical Manager

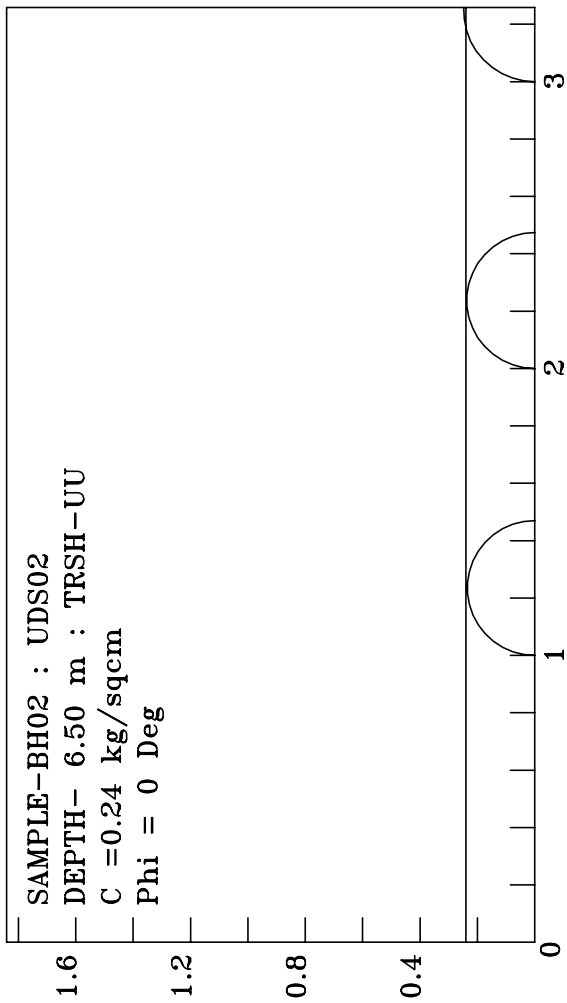
PART III: CHARTS & GRAPHS


SAMPLE-BH01 : UDS02
DEPTH- 6.50 m : TRSH-UU
C =0.09 kg/sqcm
Phi = 0 Deg
SAMPLE-BH01 : UDS05
DEPTH-18.50 m : TRSH-UU
C =0.64 kg/sqcm
Phi = 0 Deg
SAMPLE-BH01 : UDS01
DEPTH- 3.00 m : TRSH-UU
C =0.07 kg/sqcm
Phi = 0 Deg
SAMPLE-BH01 : UDS03
DEPTH-10.00 m : TRSH-UU
C =0.21 kg/sqcm
Phi = 0 Deg
SHEAR STRESS. KG/SQCM
NORMAL STRESS. KG/SQCM
0
0.4
0.8
1.2
1.6
2
1
2
3


SAMPLE-BH02 : UDS01
DEPTH- 3.00 m : TRSH-UU
C =0.20 kg/sqcm
Phi = 0 Deg
SHEAR STRESS. KG/SQCM
NORMAL STRESS. KG/SQCM


SAMPLE-BH02 : UDS05
DEPTH-17.00 m : TRSH-UU
C =0.04 kg/sqcm
Phi = 0 Deg
NORMAL STRESS. KG/SQCM

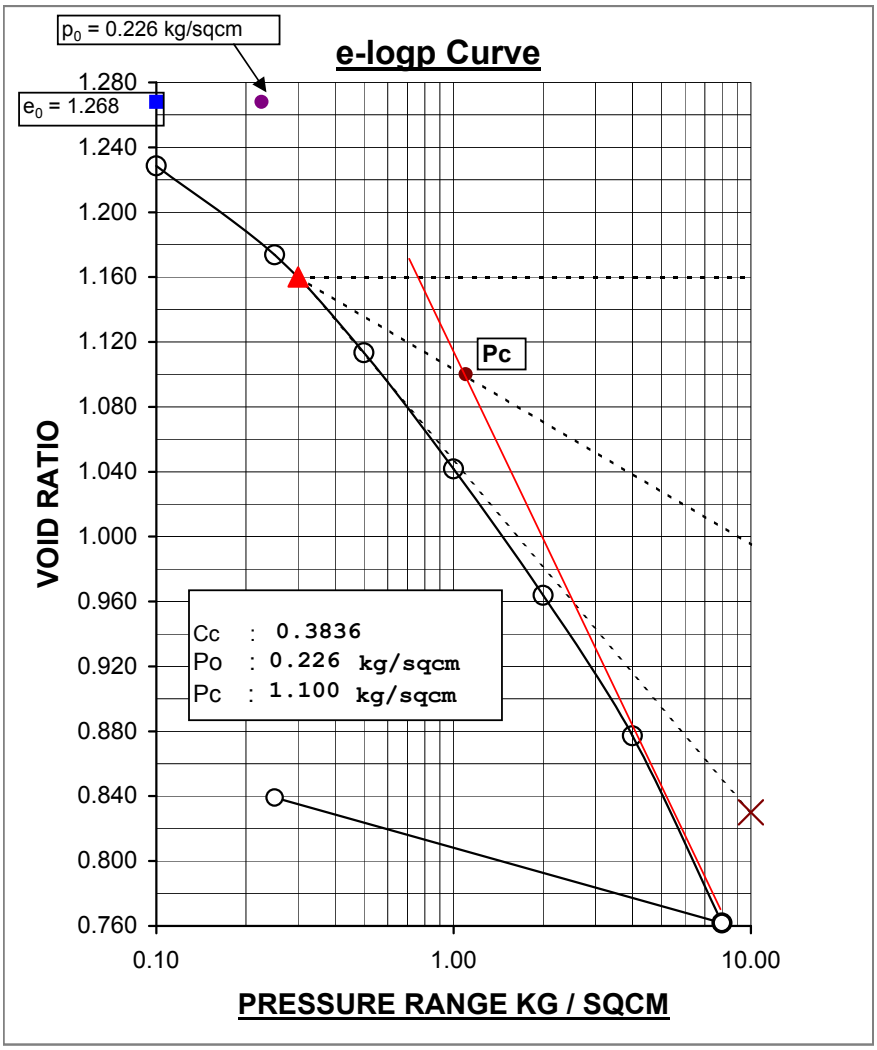

SAMPLE-BH01 : UDS06
DEPTH-22.00 m : TRSH-UU
C =0.78 kg/sqcm
Phi = 0 Deg
SHEAR STRESS. KG/SQCM
NORMAL STRESS. KG/SQCM


SAMPLE-BH02 : UDS02
DEPTH- 6.50 m : TRSH-UU
C =0.24 kg/sqcm
Phi = 0 Deg
SHEAR STRESS. KG/SQCM
NORMAL STRESS. KG/SQCM

CONSOLIDATION TEST RESULTS

Sample Number:BH-01/UDS-01 Depth :3-3.45 meters
Description :Light grey clayey silt.
Water content:Initial=49.7% Final =30.6% Initial Void Ratio =1.268

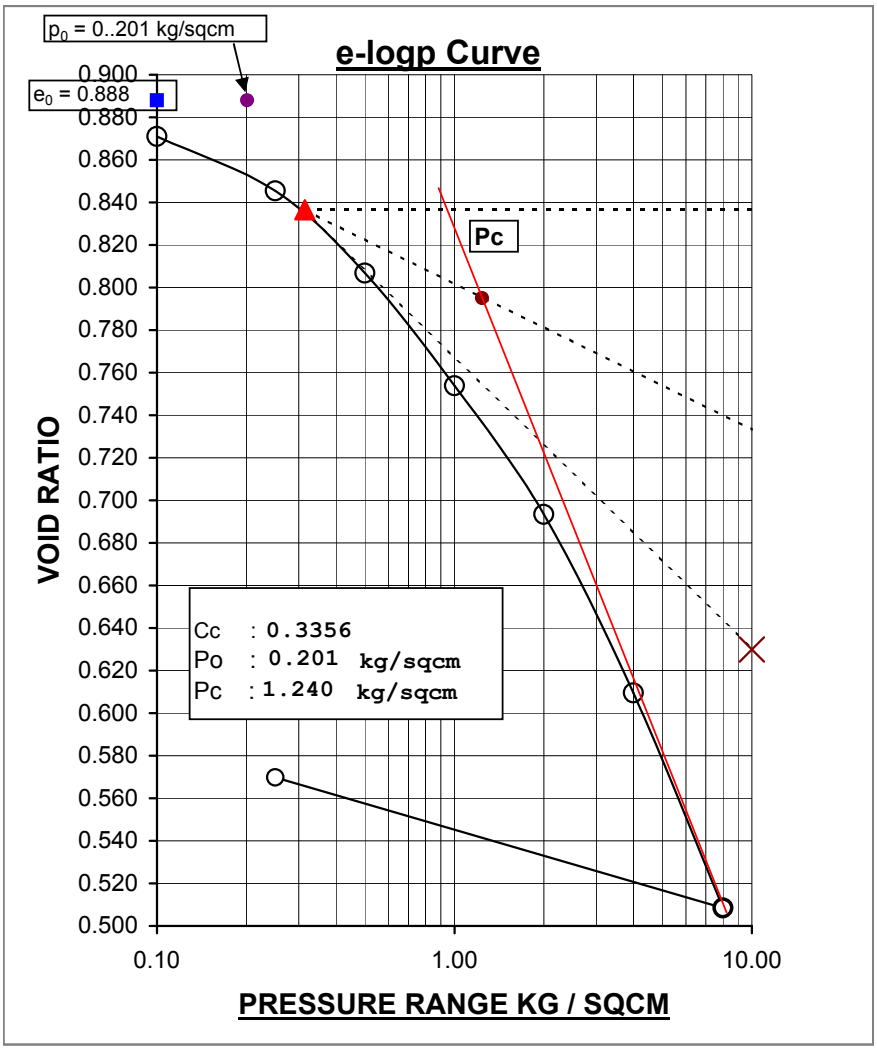
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	175	1.229	0.1750				
0.10 - 0.25	242	1.174	0.1642	11.16	0.1459	806.4	0.930
0.25 - 0.50	266	1.113	0.1110	10.90	0.0989	1054.2	0.637
0.50 - 1.00	316	1.042	0.0678	14.56	0.0580	978.5	0.599
1.00 - 2.00	343	0.964	0.0381	16.29	0.0319	1291.8	0.385
2.00 - 4.00	382	0.877	0.0221	19.63	0.0177	1506.0	0.271
4.00 - 8.00	509	0.762	0.0154	14.15	0.0132	803.7	0.385
8.00 - 0.25	341	0.839	0.0057				



CONSOLIDATION TEST RESULTS

Sample Number:BH-01/UDS-02 Depth :6.5-6.95 meters
Description : Light grey clayey silt with traces of decomposed wood & sand mixtur
Water content:Initial=47.8% Final =32.6% Initial Void Ratio =0.888

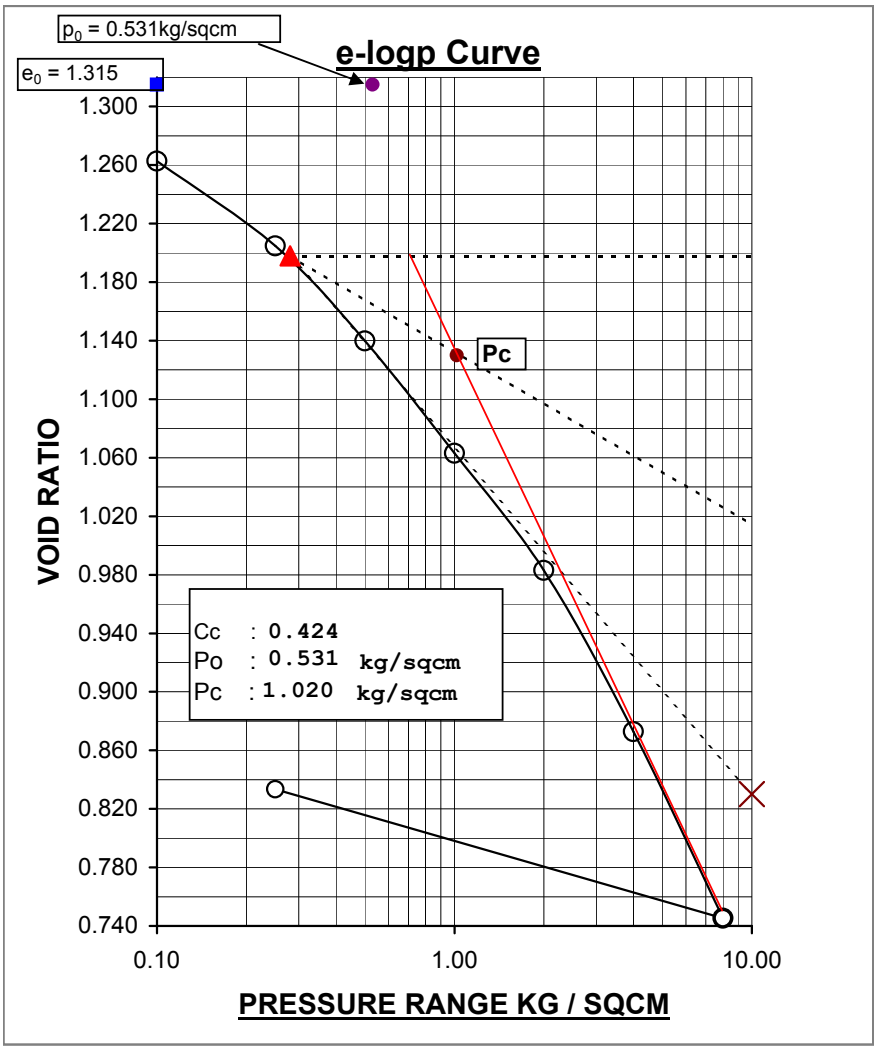
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	18	0.871	0.0900				
0.10 - 0.25	27	0.845	0.0908	8.51	0.0831	515.2	1.543
0.25 - 0.50	41	0.807	0.0839	2.44	0.0819	584.1	1.267
0.50 - 1.00	56	0.754	0.0585	19.64	0.0470	633.8	1.050
1.00 - 2.00	64	0.693	0.0345	18.75	0.0280	489.7	1.181
2.00 - 4.00	89	0.609	0.0248	7.87	0.0229	357.8	1.330
4.00 - 8.00	107	0.508	0.0157	19.63	0.0126	337.0	1.067
8.00 - 0.25	65	0.570	0.0053				



CONSOLIDATION TEST RESULTS

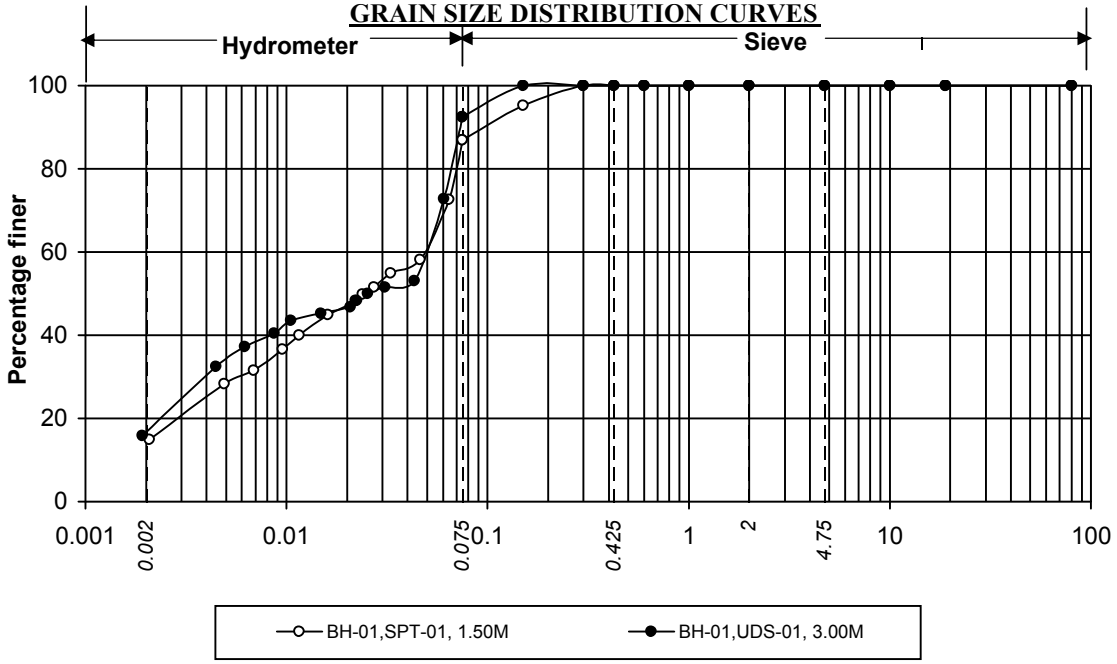
Sample Number:BH-02/UDS-02 Depth :6.5-6.95 meters
Description : Light grey clayey silt.
Water content:Initial=50.4% Final =33.7% Initial Void Ratio =1.315

P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	45	1.263	0.2256				
0.10 - 0.25	50	1.205	0.1710	14.00	0.1470	2152.8	0.339
0.25 - 0.50	56	1.140	0.1179	4.00	0.1132	1275.1	0.508
0.50 - 1.00	66	1.063	0.0716	7.58	0.0662	1242.2	0.452
1.00 - 2.00	69	0.983	0.0388	8.70	0.0354	883.9	0.534
2.00 - 4.00	95	0.873	0.0278	13.68	0.0240	936.2	0.399
4.00 - 8.00	110	0.745	0.0170	14.55	0.0146	718.3	0.372
8.00 - 0.25	76	0.833	0.0065				

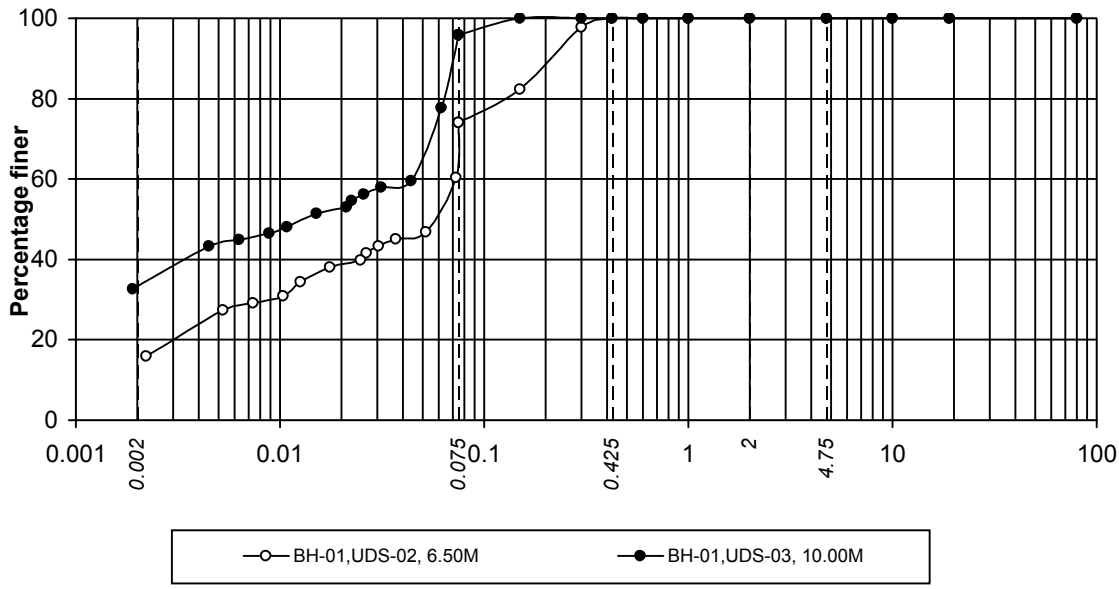


C. E. Testing Company Pvt. Ltd.

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-01,SPT-01, 1.50M	14.4	72.6	13.0	0.0	0.0	13.0		0.0
BH-01,UDS-01, 3.00M	16.6	75.8	7.6	0.0	0.0	7.6		0.0

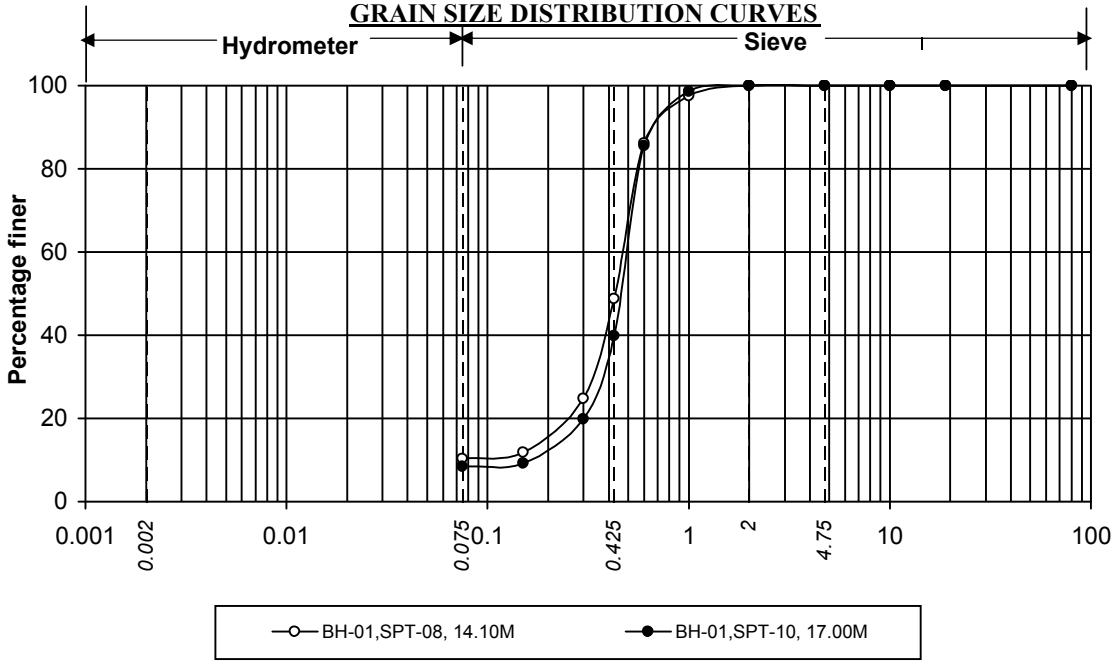


Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-01,UDS-02, 6.50M	14.6	59.4	26.0	0.0	0.0	26.0		0.0
BH-01,UDS-03, 10.00M	33.3	62.5	4.2	0.0	0.0	4.2		0.0

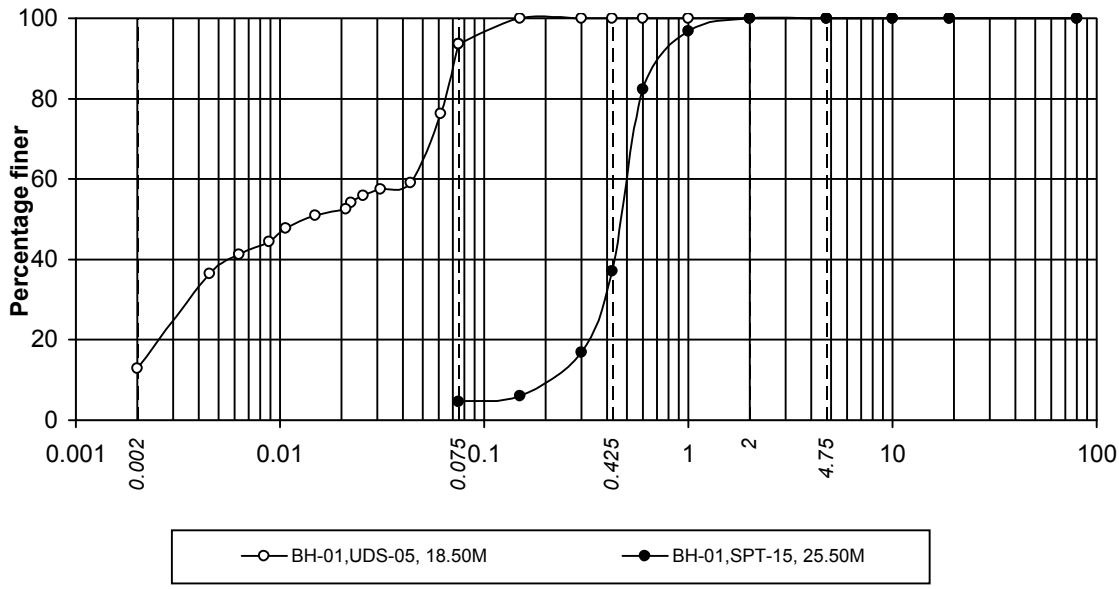
Project:- Geotechnical Investigation Work for Agartala Smart City Project, Tripura.	**Job No. 4212-02**

C. E. Testing Company Pvt. Ltd.

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-01,SPT-08, 14.10M		10.3	38.5	51.2	0.0	89.7		0.0
BH-01,SPT-10, 17.00M		8.5	31.3	60.2	0.0	91.5		0.0

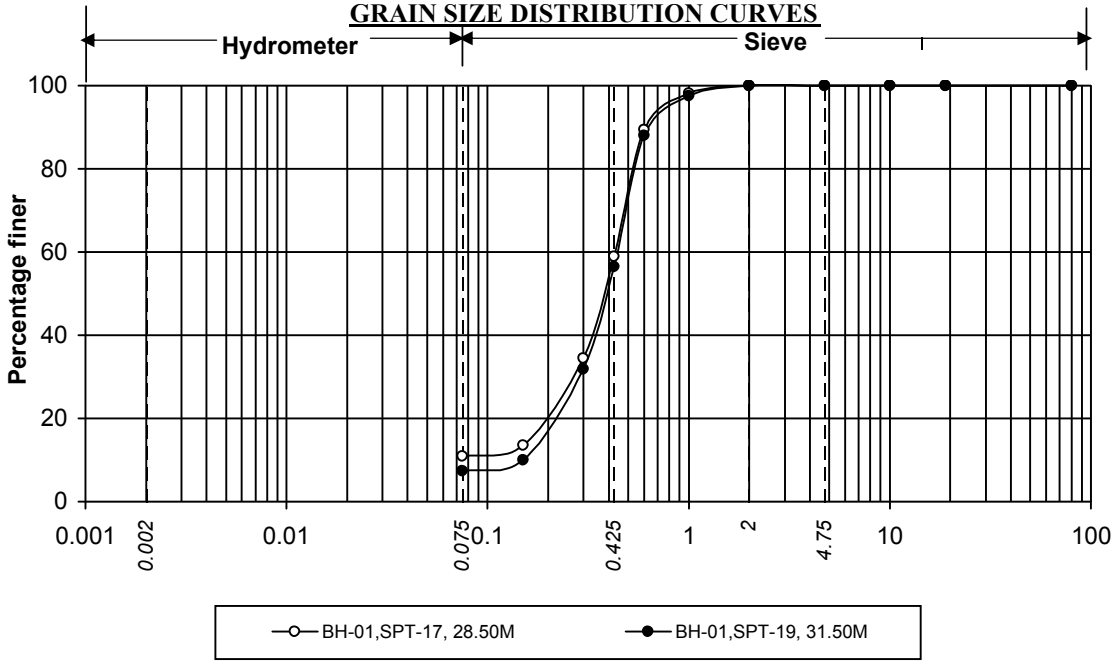


Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-01,UDS-05, 18.50M	13.0	80.6	6.4	0.0	0.0	6.4		0.0
BH-01,SPT-15, 25.50M		4.6	32.5	62.9	0.0	95.4		0.0

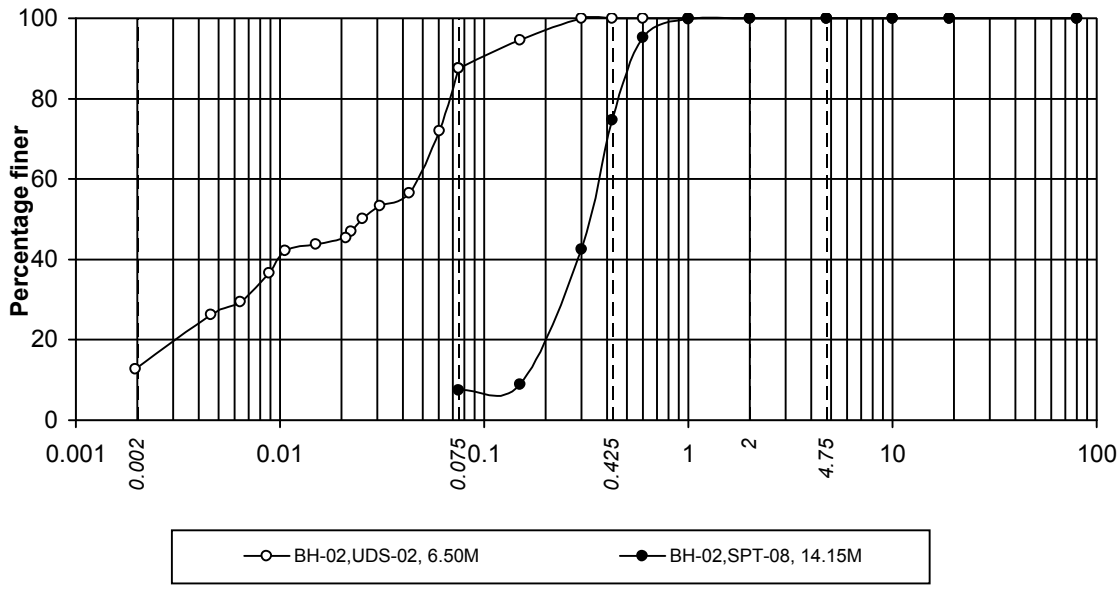
Project:- Geotechnical Investigation Work for Agartala Smart City Project, Tripura.	**Job No. 4212-02**	

C. E. Testing Company Pvt. Ltd.

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-01,SPT-17, 28.50M		11.0	47.8	41.2	0.0	89.0		0.0
BH-01,SPT-19, 31.50M		7.4	49.0	43.6	0.0	92.6		0.0

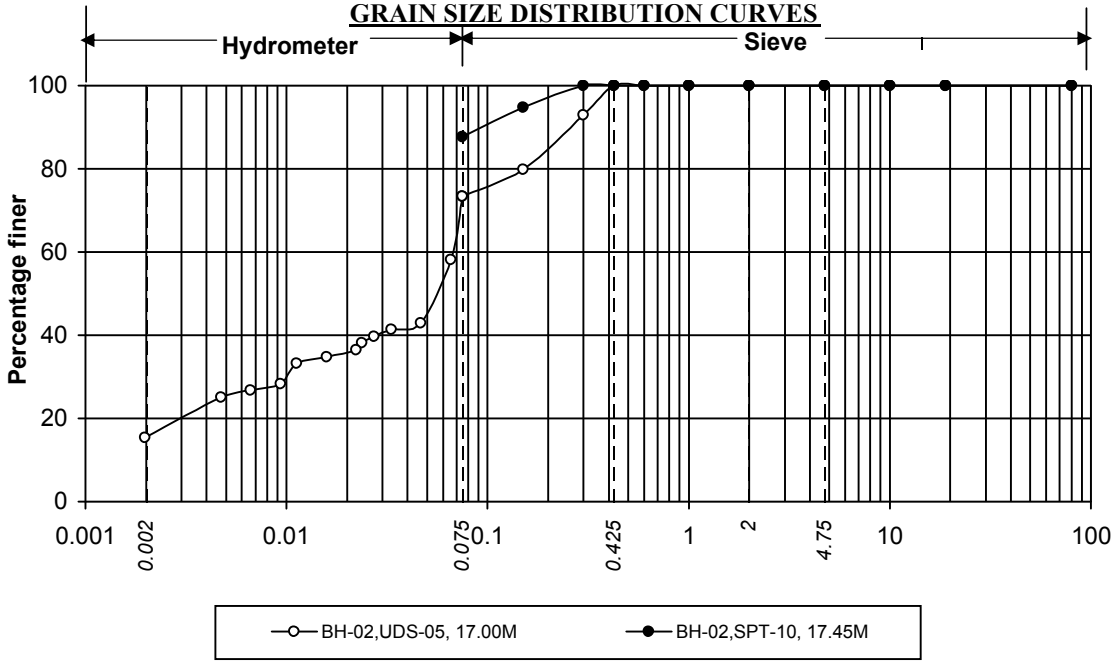


Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-02,UDS-02, 6.50M	13.1	74.5	12.4	0.0	0.0	12.4		0.0
BH-02,SPT-08, 14.15M		7.4	67.2	25.4	0.0	92.6		0.0

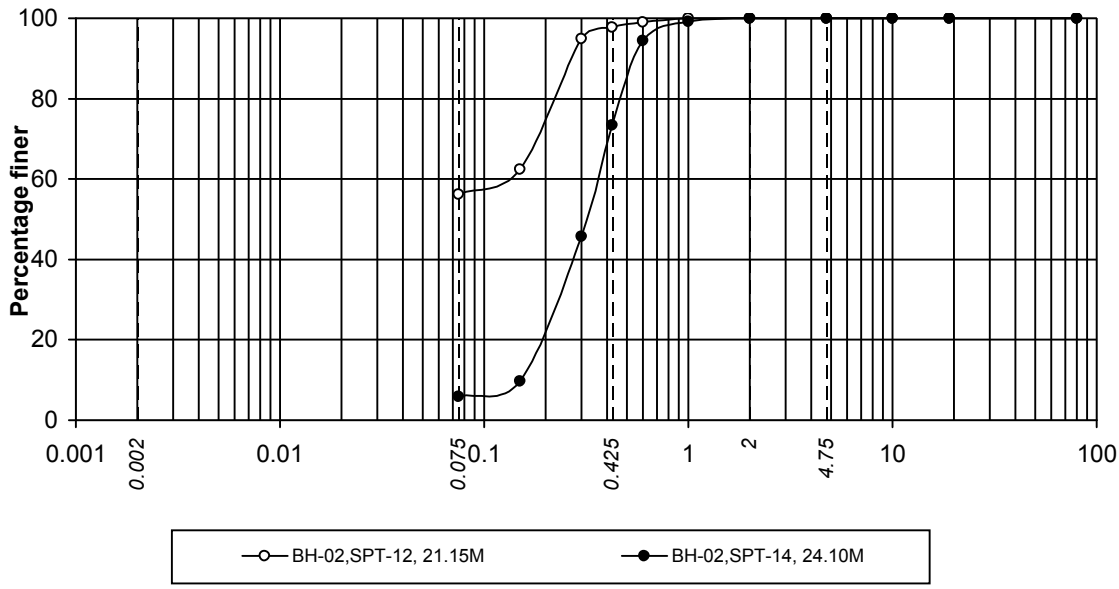
Project:- Geotechnical Investigation Work for Agartala Smart City Project, Tripura.	**Job No. 4212-02**	

C. E. Testing Company Pvt. Ltd.

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-02,UDS-05, 17.00M	15.5	57.9	26.6	0.0	0.0	26.6		0.0
BH-02,SPT-10, 17.45M		87.6	12.4	0.0	0.0	12.4		0.0

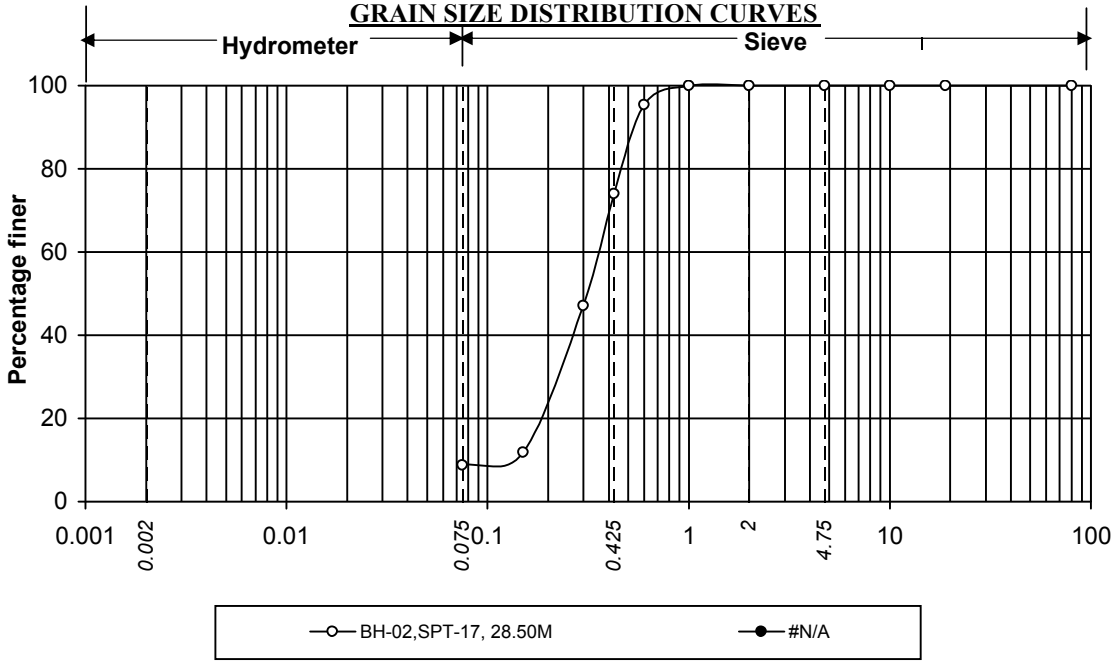


Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-02,SPT-12, 21.15M		56.2	41.6	2.2	0.0	43.8		0.0
BH-02,SPT-14, 24.10M		5.9	67.4	26.7	0.0	94.1		0.0

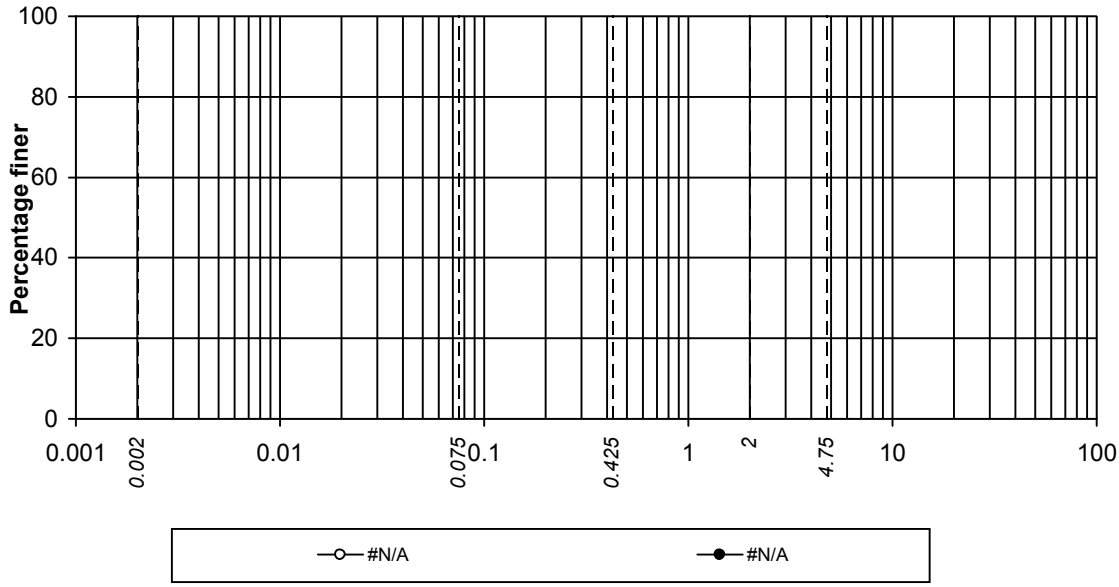
Project:- Geotechnical Investigation Work for Agartala Smart City Project, Tripura.	**Job No. 4212-02**	

C. E. Testing Company Pvt. Ltd.

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-02,SPT-17, 28.50M		8.8	65.2	26.0	0.0	91.2		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)

Project:- Geotechnical Investigation Work for Agartala Smart City Project, Tripura. | **Job No. 4212-02**

PART IV: PHOTOGRAPHS

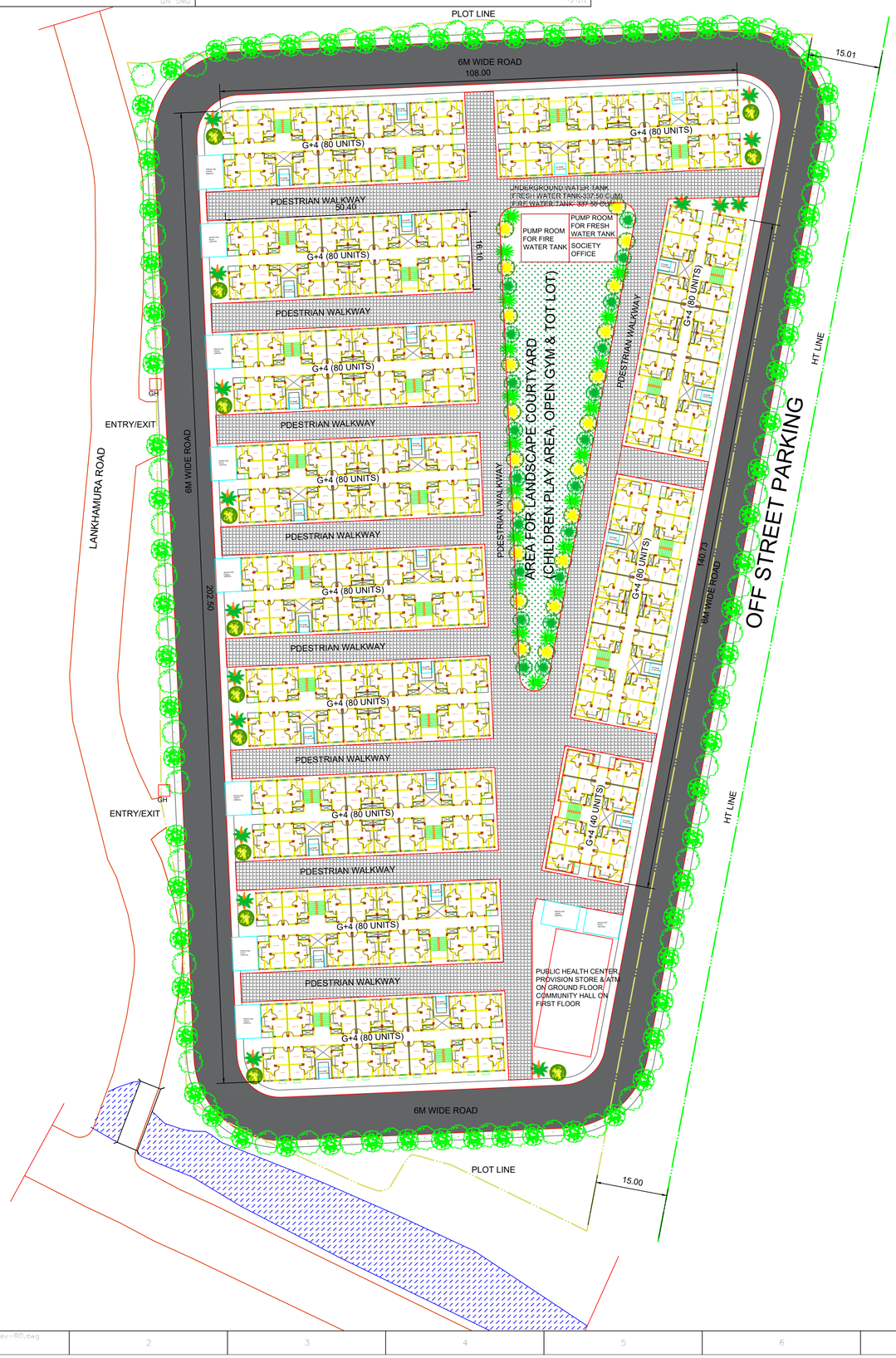

JNO-4212/021
TCEL
BUILDING
BH_01


JNO-4212/021
TCEL
BUILDING
BH_02

2.6.4 Layout Plan

DWG NO.

TITLE: PROPOSED MASTER PLAN



	SIGN.											
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	REVISIONS											
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	INITIALS											
ISSUE		DRN	DSN	CHD	CV	EL	IC	ME	PE/PM	APPD	DATE (dd-mm-yyyy)	
					CLEARED							

FOR APPROVAL

DO NOT SCALE

"P" (PRELIMINARY) ISSUES ARE NOT TO BE USED FOR CONSTRUCTION / FABRICATION BUT ARE ISSUED FOR LIMITED PURPOSES ONLY AS INDICATED IN THE SMALL BLOCK ABOVE THIS BLOCK.

CONSTRUCTION / FABRICATION WORK IS PERMITTED ON "R" (RELEASED) ISSUES ONLY.

INFORMATION CONTAINED WITHIN "HOLD" IS NOT RELEASED FOR CONSTUCTION / FABRICATION. FIELD MUST GET DESIGN OFFICE TO CLEAR "HOLDS" IN TIME BEFORE PROCEEDING WITH ANY CONSTRUCTION / FABRICATION WORK RELATED TO "HOLDS".

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FILE NAME :

LIGHT HOUSE PROJECT, UNDER THE GLOBAL HOUSING TECHNOLOGY CHALLENGE, INDIA
AGARTALA–TRIPURA

PROPOSED MASTER PLAN

TATA CONSULTING ENGINEERS LIMITED

SCALE : 1:500

DWG NO.

ISSUE P0

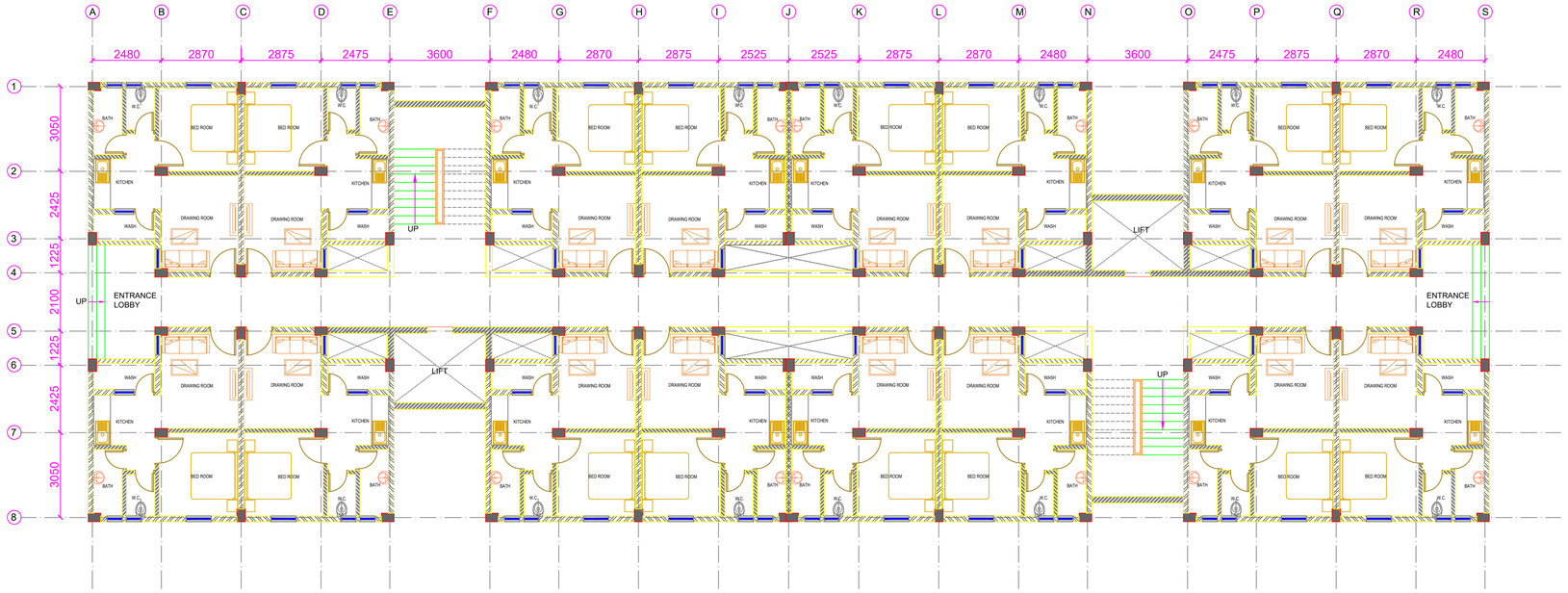
DC & DISC: NCR

FILE NAME: F-091-Rev-R0.dwg

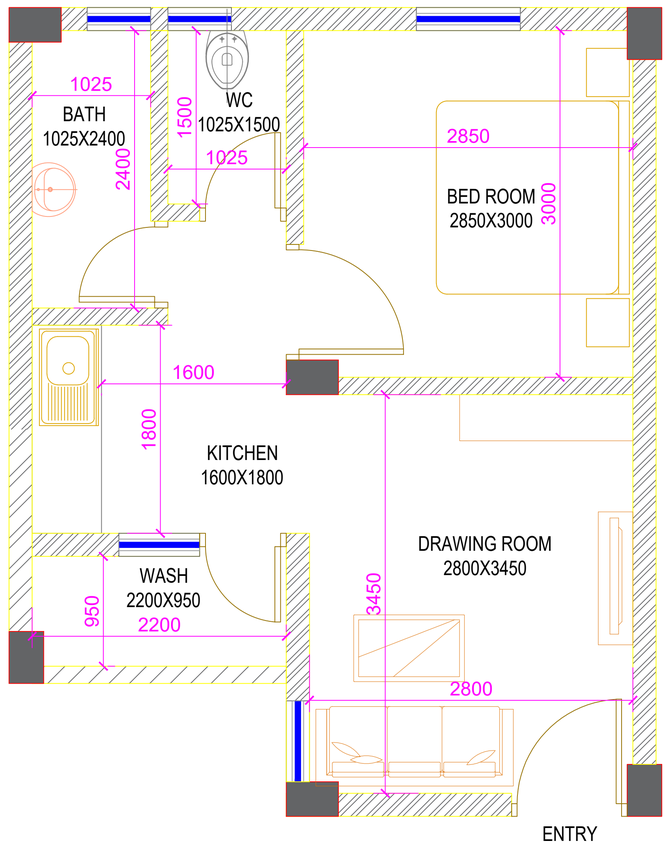
TCE FORM NO. 091 R0

2.6.5 Unit Plan

PROPOSED MASTER PLAN



GROUND FLOOR PLAN



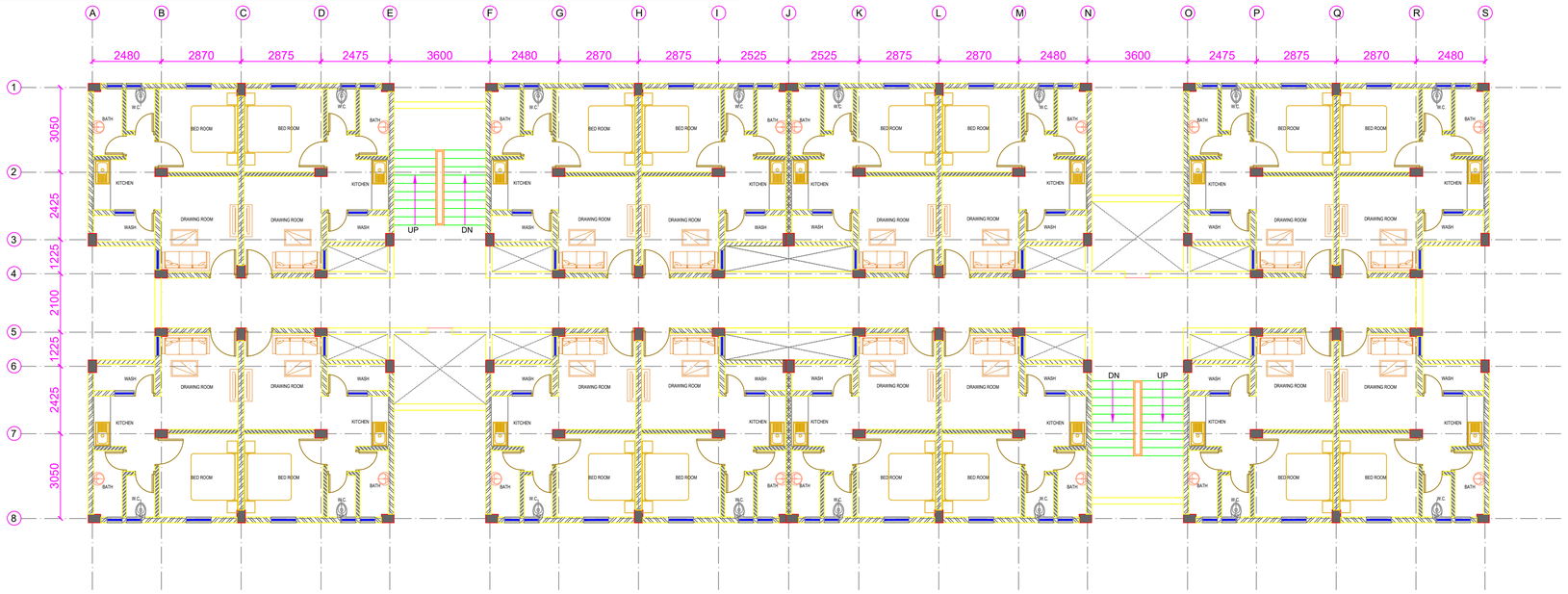
UNIT PLAN

NOTE: This is conceptual view for broad level understanding. should not be read as GFC.

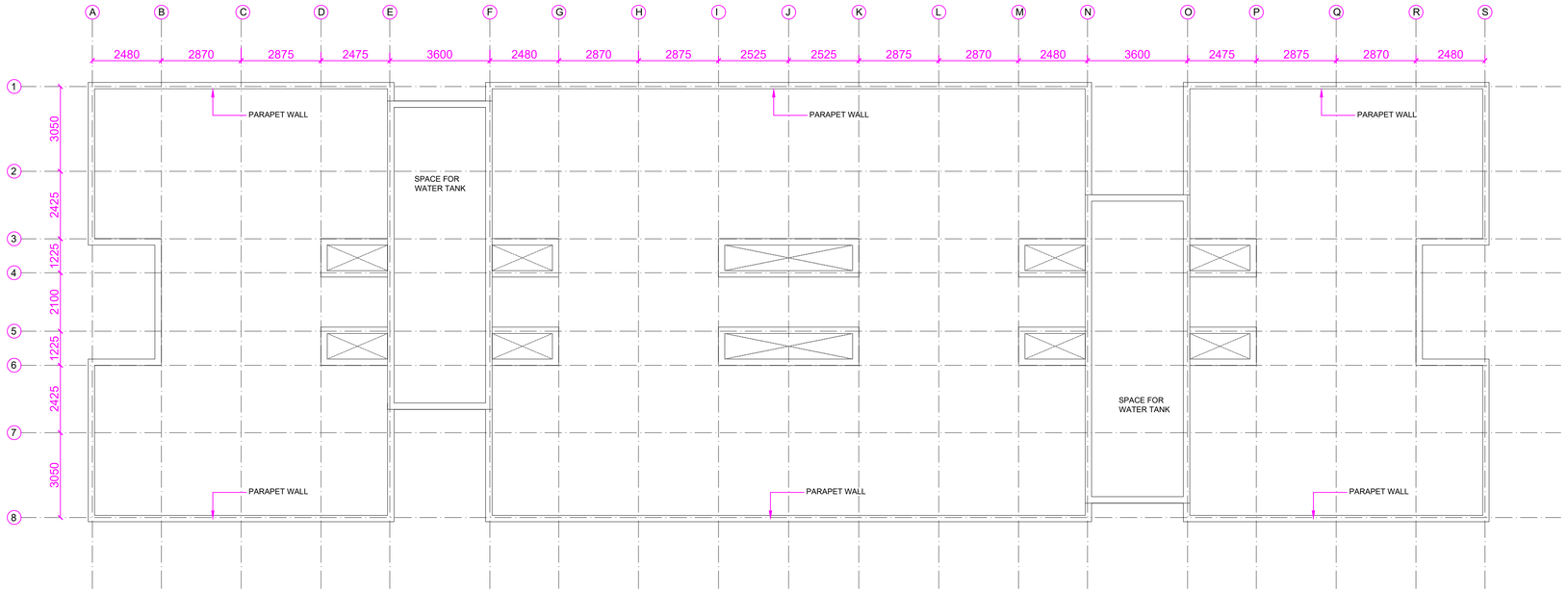
| | | |

2.6.6 Floor Plans

PROPOSED MASTER PLAN



TYPICAL PLAN FLOORS 1-4



TERRACE PLAN

NOTE: This is conceptual view for broad level understanding. should not be read as GFC.

	SIGN.																			
	INITIALS																			
	REVISIONS																			
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FILE NAME:

LIGHT HOUSE PROJECT, UNDER THE GLOBAL HOUSING TECHNOLOGY CHALLENGE, INDIA
AGARTALA–TRIPURA

PROPOSED DWELLING UNIT PLAN

TATA CONSULTING ENGINEERS LIMITED

SCALE : 1:500

DWG NO.

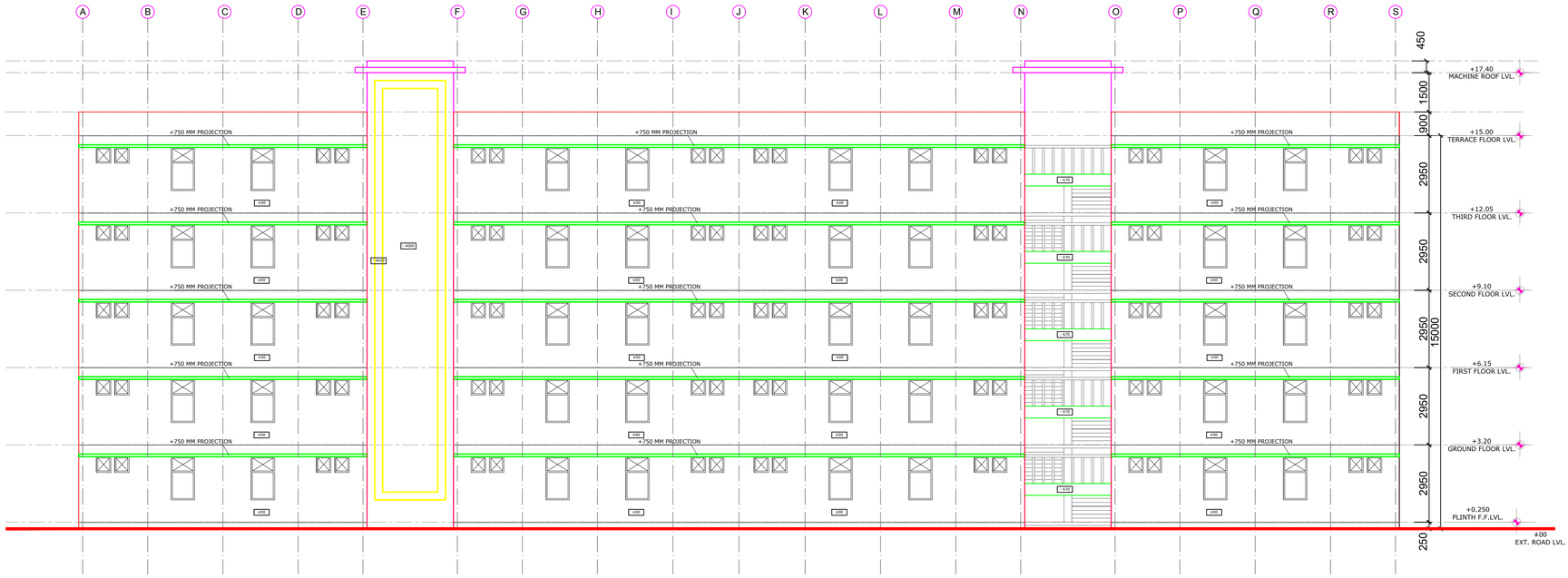
ISSUE P0

DC & DISC NCR

TCE FORM NO. 091 R0

FILE NAME: F-091-Rev-R0.dwg

PROPOSED MASTER PLAN



FRONT ELEVATION

NOTE: This is conceptual view for broad level understanding. should not be read as GFC.

	SIGN.												
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	REVISIONS												
	SIGN.												
	INITIALS												
	REVISIONS												
P0	SIGN.												
	INITIALS												
ISSUE		DRN.	DSN.	CHD.	CV.	EL.	IC.	ME.		PE/PM	APPD.	DATE (dd-mm-yyyy)	
					CLEARED								

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FILE NAME:

LIGHT HOUSE PROJECT, UNDER THE GLOBAL HOUSING TECHNOLOGY CHALLENGE, INDIA
AGARTALA–TRIPURA

PROPOSED DWELLING UNIT ELEVATION

TATA CONSULTING ENGINEERS LIMITED

SCALE: 1:500 | DWG NO. | ISSUE: P0

DC & DISC: NCR

FILE NAME: F-091-Rev-R0.dwg

TCE FORM NO. 091 R0

2.6.7 Physical Infrastructure Drawings

Water Supply	:	Gross demand for potable water supply is estimated at 0.75 mld. This demand will be met throug municipal water source. An water treatment plant (WTP) is under construction at a site adjacent to LHP site. Treated water from this WTP will be supplied to the EWS housing complex.

		Water will be received at a central underground tank having provision of captive water storage for firefighting storage also. From this central underground tank, water will be distributed through a piping network system to individual blocks. Each block will have two ground level reservoirs from which water will be pumped to overhead reservoir of the building. For Firefighting, external hydrants will be provided which will be connected to a captive water sump and pump house for fire fighting.
Storm Water Drainage System	:	A storm water drainage (SWD) network will be provided for entire complex for intercepting surface runoff generated in the housing complex. At present, two outfalls are planned to finally discharge the stormwater runoff. Estimated Runoff form the housing complex is 1.1 m^3/s for an rainfall intensity of 158 mm/hr for 20 minutes, corresponding to 5 years return period rainfall.
Sewerage System		A sewerage network connecting all building blocks of LHP will be developed. Estimated capacity of the sewerage system will be about 0.68 mld. A Sewage Treatment Plant (STP) of capacity 8 mild, is already proposed at an adjacent site located north of the LHP site. The STP will receive raw sewage from a pumping station located to the south of the LHP site, close to Akhaura Channel. The sewerage network of the LHP site will be connected to this proposed sewage pumping station.
Rain Water Harvesting	:	Ground water table is high at the proposed site. Several ponds surrounding the site are already serving as rainwater harvesting facility. These ponds are currently receiving runoff from the proposed site of LHP. The storm runoff that will be generated from the site after development of the EWS, will be diverted to these ponds and the Akhura channel.

External Electrification	:	External electrical lighting along pathways, common areas/amenities areas, etc will be provided
Electrical Services	:	Electrical power demand for the proposed development will be about 2300 kW. The power will be sourced from nearby Ramnagar Substation of capacity 33/11kV. Power will be received at site through a 5 mVA transformer and will be distributed through two feeders of 11 kV each. For Emergency/Back up power requirement, DG of capacity 100 kVA, 5 no's, will be provided.
Solid Waste Management	:	Gross generation of solid waste from 1000 households will be in the order of 1.6 Tons per day (considering 400 grams waste generation per person per day and average household size of 4). Out of the total waste,
		wet waste will be approximately 1.0 TPD and dry waste will be 0.6 TPD. Waste will be at source segregated through dry and waste bins at household level. Door to door collection from households will be done every day. At each building there will be a space at the ground level for storing collected waste. Dry waste will be recycled/to be taken away by recyclers/municipality and the organic/ wet waste will be converted to compost using organic waste converter (OWC) proposed within the housing complex. The compost so generated will be used within the green space of the complex. A space of 5m x 5m is provided for accommodating the waste converter, as well as the wheeled bins for transportation. Adequate provision for waste bins will also be provided along internal pathways at select locations, at common amenities areas etc. Any hazardous waste, e waste if generated will be stored separately and will be disposed as per statutory rules and guidelines.
Solar Light	:	Estimated generation potential of roof top solar electricity is about 630 kWp, considering availability of 6300 sq.m shadow free roof top area. This energy can be used for street lighting and other common services. Approximate cost of installation is about Rs.4.0 Cr. However, this cost is not considered in the present estimate.

~~TLE-5108~~

Received from SDM-Sadar's office on 12-03-2019

ত্রিপুরা সরকার
মানচিত্রের প্রত্যয়িত কপি

DIS WEST TRIPURA
জেলা : পশ্চিম ত্রিপুরা

CIRCLE AGARTALA
সার্কল : আগরতলা

তহশীল : রামনগর

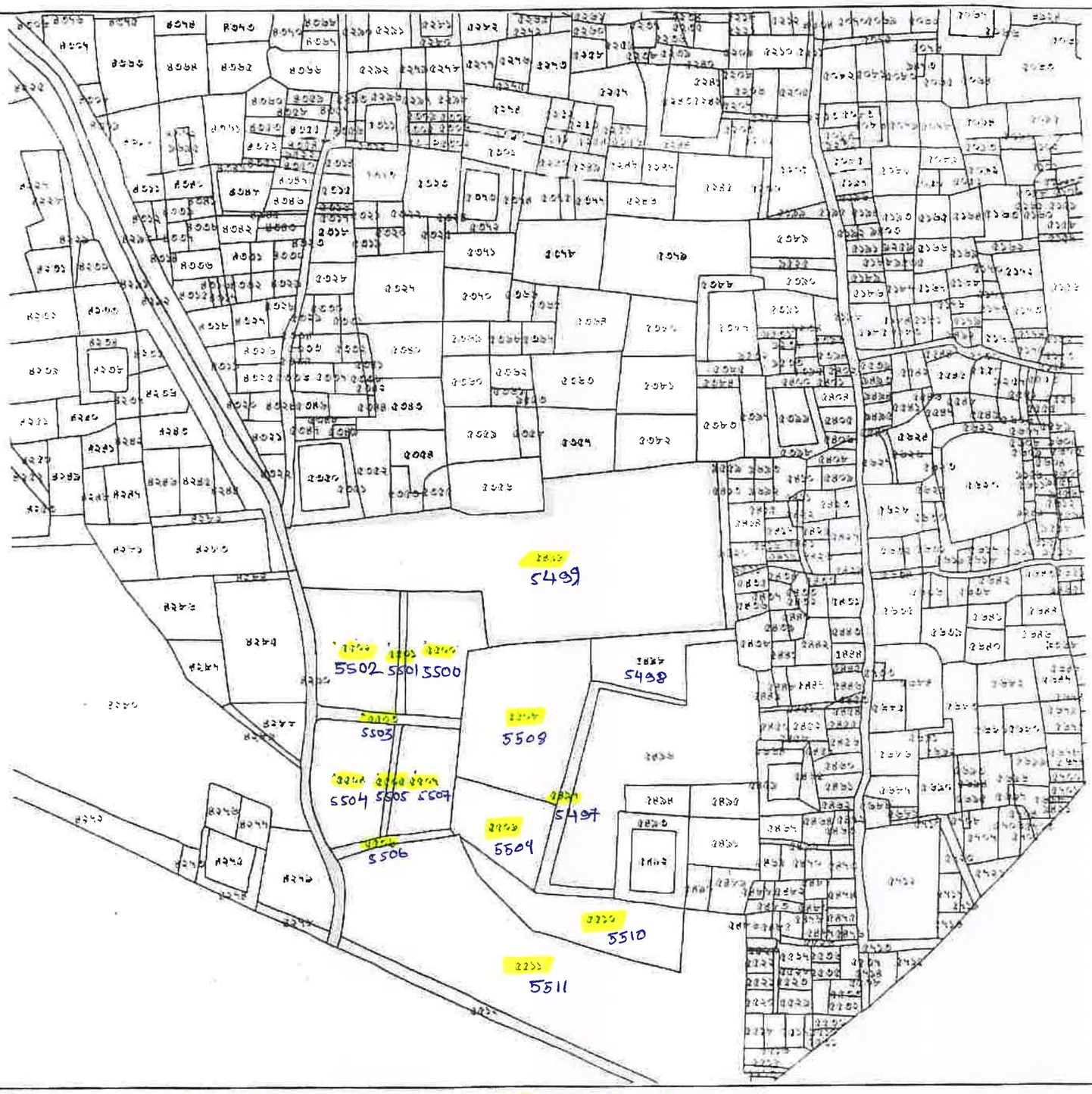
মহকুমা : সদর

মৌজা : রামনগর

সিট : ২
SHEET 2

ম্যাপ স্কেল ১ : ৪০০০

FOR GOVT. USE ONLY



জমির বিবরণ : খতিয়ান নং : ১/১১৬ KHATIAN 1/116 দাগ নং : ৫৪৯৯ DAG NO 5499

দখলকারের নাম :

ত্রিপুরা সরকারজাতি: সাধারণইউ.আই.ডি.নং :- ::::::::

Reason: Certified to be true copy of the Computerized/Digitized Finally published map.

Date: 11-03-2019

Authenticated by : Director, Land Records & Settlement, Government of Tripura. Designed & Technical support by : NIC

ত্রিপুরা সরকার

ত্রিপুরা ভূমি রাজস্ব ফর্ম - ৭

(বিধি নিয়ম ৫৩(১) ধারা দ্রষ্টব্য)

FOR GOVT. USE

মৌজা: রামনগর	খতিয়ান নং: ১/১১৬	মহকুমা: সদর
তহশীল: রামনগর	রেভিনিউ সার্কেল: আগরতলা	তৌজিনং: -

উপরিস্থ স্বত্বের বিবরণ

খতিয়ান নং	বিবরণ ও দখলকার (বিস্তারিত)	পরস্পর অংশ	রাজস্ব	যে তারিখ হইতে ধার্য্য খাজনা আমলে আসি
(১)	(২)	(৩)	(৪)	(৫)
-		০	০.০০	১৬(২) ধারা সাপেক্ষ ১৬(২) ধারা সাপেক্ষ

Reference No.: GFR-২০১২০০০৩, ALT-No.F.৩৪(৭৪)
-DEV/২০১/P২,GFR-২০১৬০০০৩

অত্র স্বত্ব

	স্বত্বের বিবরণ ও দখলকার (বিস্তারিত)	অংশ	স্বত্বের শ্রেণী ও বিবরণ	স্বত্বের বিশেষ নিয়ম ও অনুষঙ্গ	অধীনস্থ স্বত্ব, অধীনস্থ স্বত্বের পৃথক খতিয়ানের নম্বর
	(৬)	(৭)	(৮)	(৯)	(১০)
১	ত্রিপুরা সরকার	১০০,০০০			
		১০০,০০০			

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Compared By
Gouranga Datta

Authenticated By
Parimal Majumder(DCM)

ত্রিপুরা সরকার

ত্রিপুরা ভূমি রাজস্ব ফর্ম - ৭

(বিধি নিয়ম ৫৩(১) ধারা দ্রষ্টব্য)

FOR GOVT. USE

মৌজা: রামনগর | খতিয়ান নং: ১/১১৬ | মহকুমা: সদর

তহশীল: রামনগর | রেভিনিউ সার্কেল: আগরতলা | তৌজিনং: -

অত্র স্বত্বের আপন দখলীয় জমি

দাগ নম্বর		উত্তর সীমানা		জমির শ্রেণী Class of land	মন্তব্য	অত্র স্বত্বের বসবাসীয় পরিমাণ			
						একর	শতক	হেক্টর	আর
সাবেক (১১)	হাল HAL (১২)	দাগ নম্বর DAG NO (১৩)	দখলকার OWNER (১৪)	(১৫)	(১৬)	(১৭)		(১৮)	
৮০১৯অং	৩৯৩	৩৯৬	ত্রিপুরা সরকার	বাগান (টিলা)		০	১০০	০	০৪০
৮০১৯অং	৩৯৪	৩৯৬	ত্রিপুরা সরকার	টিলা		০	০৬০	০	০২৪
৮০১৯অং	৩৯৫	৩৯৭	নির্মলা	টিলা		০	০৫০	০	০২০
৮০১৯অং	৩৯৬	৪০৩	নির্মলা	ভিটী (টিলা)		০	০৪০	০	০১৬
৩৪৫৭ অং	৫৪৯৬	৫৪৯৭ 54	নিজ	বিল (টিলা)	৬/১৫ নং খতিয়ান হইতে আগত	২	২০০	০	৮৯০
৩৪৫৭ অং	৫৪৯৮ 5498	৫৪৯৯	মৎস্য বিভাগ Fishery Dept.	ভিটী (নাল)	৬/২৬ নং খতিয়ান হইতে আগত	০	৫৫০	০	২২৩
৩৪৫৭অং,	৫৪৯৯ 5499	৫৩৫১	প্রফুল্ল গং Prafulla Gang	বিল (নাল)	৬/২৬ নং খতিয়ান হইতে আগত	৪	৯৮০	২	০১৫
৩৪৫৭অং,	৫৫০০ 5500	৫৪৯৯	মত স্য বিভাগ Fishery Dept.	নাল	৬/২৬ নং খতিয়ান হইতে আগত	০	৮৪০	০	৩৪০
৩৪৫৭অং,	৫৫০১ 5501			রাস্তা	সাধারনের ব্যবহার্য্য, ৬/২৬ নং খতিয়ান হইতে আগত	০	০৯০	০	০৩৬
৩৪৫৭অং,	৫৫০২ 5502	৫৪৯৯	মৎস্য বিভাগ Fishery Dept.	নাল	৬/২৬ নং খতিয়ান হইতে আগত	০	৯৪০	০	৩৮০
৩৪৫৭অং,	৫৫০৩ 5503			রাস্তা	সাধারনের ব্যবহার্য্য, ৬/২৭ নং খতিয়ান হইতে আগত	০	১৪০	০	০৫৭
PB১২৪- -৩৪৫৭অং,	৫৫০৪ 5504			নাল	৬/২৭ নং খতিয়ান হইতে আগত	০	০৩০	০	০১২
৩৪৫৭অং,	৫৫০৫ 5505			রাস্তা	সাধারনের ব্যবহার্য্য, ৬/২৭ নং খতিয়ান হইতে আগত	০	০৭০	০	০২৮
PB১৪২- -৩৪৫৭অং,	৫৫০৬ 5506			রাস্তা	সাধারনের ব্যবহার্য্য, ৬/২৭ নং খতিয়ান হইতে আগত	০	০৫০	০	০২০
৩৪৫৭অং,	৫৫০৭ 5507		রাস্তা Road	নাল	৬/২৭ নং খতিয়ান হইতে আগত	০	৫৬০	০	২২৭
৩৪৫৭অং,	৫৫০৮ 5508	৫৫০০	নিজ Personal	খেলার মাঠ (নাল)	৬/২৫ নং খতিয়ান হইতে আগত	১	৬২০	০	৬৫৬

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ত্রিপুরা সরকার

ত্রিপুরা ভূমি রাজস্ব ফর্ম - ৭

(বিধি নিয়ম ৫৩(১) ধারা দ্রষ্টব্য)

FOR GOVT. USE

মৌজা: রামনগর	খতিয়ান নং: ১/১১৬	মহকুমা: সদর
তহশীল: রামনগর	রেভিনিউ সার্কেল: আগরতলা	তৌজিনং: -

৩৪৫৭অং,	৫৫০৯ 5509	৫৫০৮	নিজ Personal	বিদ্যালয় (নাল)	প্রঃ হরিজন কলোনী বুনিয়াদী বিদ্যালয় টিনঘর---২, ৬/২৫ নং খতিয়ান হইতে আগত	০	৬২০	০	২৫১
৩৪৫৭অং,	৫৫১০ 5510	৫৫০৯	নিজ Personal	ভিটী (নাল)	৬/২৫ নং খতিয়ান হইতে আগত	০	৯৪০	০	৩৮০
PB-৪৪৮৯-৩৪৫৭অং,	৫৫১১ 5511	-	রাস্তা ROAD	বিল (নাল NAL)	৬/২৫ নং খতিয়ান হইতে আগত	০	০৭৫	০	০৩০
PB- ৪৪৮৯, ৩৪৫৭অং,	৫৫১১/১৯৮৪৫	-	রাস্তা Road	বাস্তু (নাল)	৬/২৫ নং খতিয়ান হইতে আগত, Revenue Case No. ৬৭/১৮ U/S ২০	০	০৭৫	০	০৩০
মোট দাগ: ২০					আপন দখলীয় জমির মোট	১৪	০৩০	৫	৬৭৫
					জের	০	০০০	০	০০০
					অধীনস্থ স্বত্বের মোট	০	০০০	০	০০০
					সর্ব্বমোট				

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Parimal Majumder(DCM)

R-no-90

Team leader, PHC. DM,

GOVERNMENT OF TRIPURA.
OFFICE OF THE DISTRICT MAGISTRATE & COLLECTOR.
WEST TRIPURA DISTRICT: AGARTALA.
(REVENUE SECTION)

No F.17 (5)-DM/W/REV/2017/ 3342-43 Dated- 25.10.2018

To
The Chief Executive Officer
Agartala Smart City Ltd.

Subject: - Regarding permission for filling up of pond near integrated Check Post(ICP) at Akhaura Golchakkar adjacent to Akhaura Road.

Sir,

In reference to your letter vide No.F.2(5)/ASCL/2018/1272-1275 dated 07/09/2018 on the subject cited above, this is to inform you that the diversion permission of land measuring 0.075 acres in RS Plot No.5511 corresponding to CS Plot No.3457/p recorded in Khatian No.1/116 of mouja Ramnagar has been issued by the Deputy Collector & Magistrate, Agartala Revenue Circle vide order No.F.1(12) /DCM/AGT/REV/15/3806-08 dated 12-10-2018(copy enclosed).

This is for your information please.

Yours faithfully

Enclo: - As stated.

25/10/18
[U.J.Mog]
Addl. District Magistrate & Collector,
West Tripura: Agartala.

Copy to:-
The Sub-Divisional Magistrate, Sadar for information. This has a reference to his letter No.F.4(10)/SDM.SDR/REV/2017/4372-73 dated.12/10/2018.

TRIPURA GOVERNMENT
URBAN OF DEVELOPMENT DEPARTMENT
3RD FLOOR OF KHADYA BHAVAN, PANDIT NEHRU COMPLEX
AGARTALA: TRIPURA (W)

NO.F.2(8)-TUDA/Tech/2019/53-55 Dated, Agartala, the 29th May, 2019

Asst. M. & (C2) Dev cell

RECEIVED
Date 30-5-19
No. 15477
Agartala Municipal Corporation

To
The District Magistrate & Collector,
West-Tripura.

Subject- Allotment of Khas land measuring 13.78 acre of Ramnagar Mouja located at Gol-chakkar area in the name of Tripura Urban Planning & Development Authority (TUDA) for construction of Light House Project under PMAY(U) scheme.

Sir,

In reference to the subject cited above this to inform you that the State Government has established the Tripura Urban Planning & Development Authority (TUDA) under the Tripura Urban Planning and development Act 2018. In its 1st meeting it was decided that available vacant Government lands in and around Agartala city will be transferred in the name of TUDA free of encumbrance and free of cost for development of townships for residential, commercial of mixed purpose.

In this regard it is to mention that Ministry of Housing and Urban Affairs (MoHUA) has sanctioned prestigious a Light House Project under PMAY(U) in Akhawrah Golchakkar area under Ramnagar Mouja for construction of 1000 multi storied dwelling units for Economically weaker sections (EWS) to showcase latest, modern, innovative eco-friendly, earthquake resilient, faster housing construction technologies at regional and national level.

At present, the land is recorded in the name of Government of Tripura. Therefore, I would request you to kindly allot the said khas land in favor of Tripura Urban Planning & Development Authority (TUDA). The details of the land are attached in Annexure.

Enclo: As stated.

Yours faithfully

29/5/2019.

Commissioner, TUDA

Copy to:

1) P.S to the Special Secretary, UDD, Tripura for kind information of Special Secretary.
2) Municipal Commissioner, Agartala Municipal Corporation for kind information.

Land details-

ANNEXURE

Khatian No & Mouja	R/S Plot No	Area (Acre)	Land Classification
Ramnagar 1/116	5496	2.2	Bil(Nal)
	5498	0.55	Viti(Nal)
	5499	4.98	Bil(Nal)
	5500	0.84	Nal
	5501	0.09	Road
	5502	0.94	Nal
	5503	0.14	Road
	5504	0.03	Nal
	5505	0.07	Road
	5506	0.05	Road
	5507	0.56	Nal
	5508	1.62	Play Ground
	5509	0.62	Vidyalay
	5510	0.94	Viti(Nal)
	5511	0.075	Bil(Nal)
	5511/19845	0.075	Bastu
Total area-		**13.78**	